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A REVISION OF THE GENUS TELINE

being a Thesis

presented by

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to the

University of St. Andrews

in application for

THE DEGREE OF MASTER OF SCIENCE



Tu 5721

(i)

DECLARATION

I declare that this thesis is based upon studies carried out by me, that it is of my own composition and has not been submitted previously in application for a higher degree.

The research was carried out in the Department of Botany, St. Salvator's College, University of St. Andrews, under the direction of Dr P.E. Gibbs.

(ii)

CERTIFICATE

I hereby certify that Mrs Ingrid Dingwall, B.Sc., has spent four terms at research work under my supervision, has fulfilled the conditions of Ordinance No. 51 (St. Andrews), and is qualified to submit the accompanying thesis in application for the degree of M.Sc.

Research Supervisor.

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INTRODUCTION

Teline (Leguminosae, tribe Genisteae) is a small genus which is centered in the Canary Islands. Since it was recognised in 1787 by Medikus, Teline has had a varied taxonomic history. Most authors have considered it to be a subgenus or section of either Genista (following Spach, 1845) or Cytisus (following Bentham, 1862), two genera which show close affinities with Teline. However, Webb and Berthelot (Phytographia Canariensis, 1842) and Gibbs (1966, 1968) have preferred to recognise Teline as a distinct genus. After morphological and anatomical studies this treatment has been followed in this account.

In the light of the present investigation, Teline comprises nine species distributed in Macaronesia and the Mediterranean region. Two species, T. monspessulana and T. linifolia, have fairly widespread distributions, occurring in the Mediterranean region and various Atlantic islands. Of the other species, T. osmariensis is apparently endemic to a single mountain in Morocco and the remaining six species each occur on only one or two of the Macaronesian islands. The latter species present many of the problems of island micro-endemism, for example, poorly differentiated races below species level, and few barriers to interspecific hybridisation other than geographical isolation.

A number of Teline species are commonly grown as ornamental

plants and for hedging, particularly where winter frost is not too severe. Due to interspecific hybridisation and the lack of taxonomic studies on species limits, there is much confusion in the horticultural trade as to the nomenclature and identification of cultivated taxa. This situation is most obvious in the United States (particularly the State of California) where cultivated plants have become naturalised and hybridisation between at least three species has occurred.

The present account attempts to revise the genus Teline as fully as is possible with a study of literature, herbarium specimens and, where available, living plants in cultivation. An attempt has also been made to clarify the situation in California and to assess the parentage of the hybrid specimens mentioned above.

SECTION I

RE-ESTABLISHMENT OF THE GENUS

TELINE

RE-ESTABLISHMENT OF THE GENUS TELINE

Most authors have recognised the taxon Teline as a subgenus or section under the genera Genista or Cytisus, since it possesses some characters otherwise restricted to either of the latter genera. However, Medikus (1787), the first author to recognise Teline, described it as a genus. He included in Teline only one species, T. monspessulana (T. medicagoides Medik.) but commented that several other species appeared to differ from Genista (sensu Medikus) in the same way as T. monspessulana, although he gave no specific diagnostic characters. Webb and Berthelot (1842), who followed Medikus in recognising Teline as a genus, distinguished it from Genista by its strophiolate seeds, and from Cytisus by its deeply cleft calyx upper lip and oblong keel petal. These authors enlarged Teline to include eight species from the Mediterranean, Canary Islands and Madeira: T. candicans (L.) Webb & Berthelot¹, T. maderensis W. & B., T. canariensis (L.) W. & B., T. ramosissima (Poir.) W. & B., T. stenopetala W. & B., T. congesta (Willd.) W. & B., T. linifolia (L.) W. & B. and T. rosmarinifolia W. & B.

Spach preferred to recognise Teline as a subgenus under Genista, since Teline resembles Genista in possessing a deeply cleft calyx upper lip and an oblong keel petal. He included in subg. Teline, in addition to the eight species recognised by Webb and Berthelot, Genista virgata Ait. Several authors have followed Spach in

¹ ie. Cytisus monspessulanus L.

referring Teline as a section or subgenus to Genista eg., Lowe (1868), Christ (1888) and Rouy and Foucaud (1897). Pellegrin (1908) found that Teline also resembles Genista in its nodal anatomy: in an extensive investigation of the Genisteeae he found that Teline, like Genista subg. Genista and subg. Spartocarpus, has three vascular leaf traces, whereas Genista subg. Phyllobotrys has only one vascular trace, and Cytisus has one vascular and two lateral fibrous leaf traces. Pellegrin therefore followed Spach in treating Teline as a subgenus of Genista; however on the basis of his anatomical investigations he followed Briquet (1894) in including Cytisus patens, which he found had three vascular leaf traces. Subsequently Vicioso (1953) also followed Briquet in including Cytisus tribracteolatus, although Pellegrin had rejected this species on anatomical grounds.

Bentham (1862), however, referred Teline to the genus Cytisus, thus emphasising the presence or absence of a seed strophiole as a diagnostic character: in both Teline and Cytisus the seed is strophiolate, whereas in Genista the seed lacks a strophiole. Leaf foliolation is another \pm diagnostic character used by Bentham: like most Cytisus species, Teline has trifoliolate leaves, whereas in Genista the leaves are usually unifoliolate. Consequently Bentham referred sect. Teline to Cytisus, and most authors have followed this treatment, eg. Boissier (1872), Willkomm and Lange (1877), Ball (1878), Masferrer (1881), Taubert (1894), Pitard and Proust (1909) and Holubová-Klásková (1964). Briquet (1894)

recognised three subsections of Cytisus sect. Teline:

Cephaloteline: flowers in terminal heads or racemes (C. canariensis,
C. spachianus, C. hillebrandtii, C. maderensis, C. paivae,
C. congestus, C. cincinnatus, C. linifolius).

Phylloteline: flowers pseudo-umbellate, on lateral branchlets
(C. monspessulanus, C. osmariensis).

Pleuroteline: flowers lateral, axillary (C. patens, C. tribracteolatus).

No other authors have recognised subsections under Teline.

Hutchinson (1918) in a review of Canary Island species of Cytisus as fodder plants added three more species, C. proliferus,
C. perezii and C. palmensis, to section Teline.

Gibbs (1966, 1968) has re-established Teline as a genus, pointing out that although the species of Teline are intermediate between Genista and Cytisus in that they possess some characters of both these genera, they nevertheless present a distinct and homogeneous group which should be considered as a separate genus. After some investigation this treatment has been followed in the present account.

Generic limits

The species included in the genus Teline by Webb and Berthelot (1842), together with species recognised as referable to this taxon by subsequent authors, were included in the investigation on the limits of Teline:

<u>Teline monspessulana</u> (L.) Koch	<u>G. virgata</u> Ait.
<u>T. canariensis</u> (L.) W. & B. ¹	<u>G. paivae</u> Lowe
<u>T. ramosissima</u> (Poir.) W. & B.	<u>G. osmariensis</u> Coss.
<u>T. maderensis</u> W. & B.	<u>Cytisus patens</u> (Cav.) D.C., <u>non</u> L.
<u>T. stenopetala</u> W. & B.	<u>C. tribracteolatus</u> W. & B.
<u>T. congesta</u> (Willd.) W. & B. ²	<u>C. cincinnatus</u> Ball
<u>T. linifolia</u> (L.) W. & B. ³	<u>C. perezii</u> Hutch.
<u>T. rosmarinifolia</u> W. & B. ³	<u>C. palmensis</u> Hutch.
<u>Genista spachiana</u> Webb	<u>C. proliferus</u> L.

Two species immediately excluded from Teline were Genista virgata Ait. and Cytisus cincinnatus Ball. G. virgata has unifoliolate leaves and estrophiolate seeds, unlike Teline species, and therefore remains in Genista. C. cincinnatus has already been referred to the genus Adenocarpus by Gibbs (1967). The remaining fourteen species were investigated more fully, using both anatomical and morphological criteria.

¹ No specimens of Genista hillebrandtii Christ (included in Teline by Briquet, 1894) were available, but it was later found that G. hillebrandtii is probably a synonym for T. canariensis.

² ie. G. microphylla (DC.) Gibbs & Dingwall.

³ In this account T. rosmarinifolia W. & B. is included in T. linifolia (L.) W. & B. as a subspecies; T. linifolia var. latifolia W. & B. is also considered to be a subspecies (subsp. pallida) and T. linifolia var. angustifolia W. & B. is divided into two subspecies, subsp. linifolia and teneriffae.

1. Anatomyi) Nodal anatomy

Pellegrin (1908) found that in Genista three vascular traces pass to the leaf (with the exception of subg. Phyllobotrys where there is only one leaf trace) whereas in Cytisus one vascular and two fibrous traces pass to the leaf. Teline, like Genista, has three vascular traces. In this investigation the following types of anatomy were found:

<u>1 vascular leaf trace</u>	<u>3 vascular leaf traces</u>	<u>2 fibrous, 1 vascular leaf trace</u>
<u>G. anglica</u> ¹	<u>G. tinctoria</u>	<u>C. hirsutus</u>
<u>G. hispanica</u>	<u>G. januensis</u>	<u>C. sessilifolius</u>
	<u>G. pilosa</u>	<u>C. purpureus</u>
	<u>G. radiata</u>	<u>C. scoparius</u>
	<u>G. salzmannii</u>	<u>C. albus</u>
	<u>G. aetnensis</u>	<u>C. ardoinii</u>
	<u>G. lobelii</u>	<u>C. patens</u>
	<u>T. monspessulana</u>	<u>C. tribracteolatus</u>
	<u>T. canariensis</u>	<u>C. perezii</u>
	<u>T. ramosissima</u>	<u>C. proliferus</u>
	<u>T. maderensis</u>	<u>C. palmensis</u>
	<u>T. stenopetala</u>	
	<u>T. microphylla</u>	
	<u>T. linifolia</u>	
	<u>T. rosmarinifolia</u>	
	<u>G. spachiana</u>	
	<u>G. paivae</u>	
	<u>G. osmariensis</u>	

¹ The nodal anatomy and leaf morphology of nine Genista and six Cytisus species had been investigated in an Honours research project (1966-1967).

Fig. 1 (A - C) Nodal anatomy in Teline, Cytisus and Genista species: transverse sections of the stem, through the inter-node and node (source material is indicated in brackets)

A Teline canariensis (Tenerife, 'in sylvaticus montanae mediae', IV-V. 1855, Bourgeau 1302, MANCH)

B Cytisus sessilifolius (cultivated specimen)

C Genista hispanica (cultivated specimen)

In Figs. 1 - 5, the following symbols are used:

1, 2 and 3	vascular leaf traces
Uniform white	parenchyma
Uniform black	xylem
Stippling	phloem
Hatching	sclerenchyma
Crosshatching	collenchyma
Broken lines	photosynthetic parenchyma

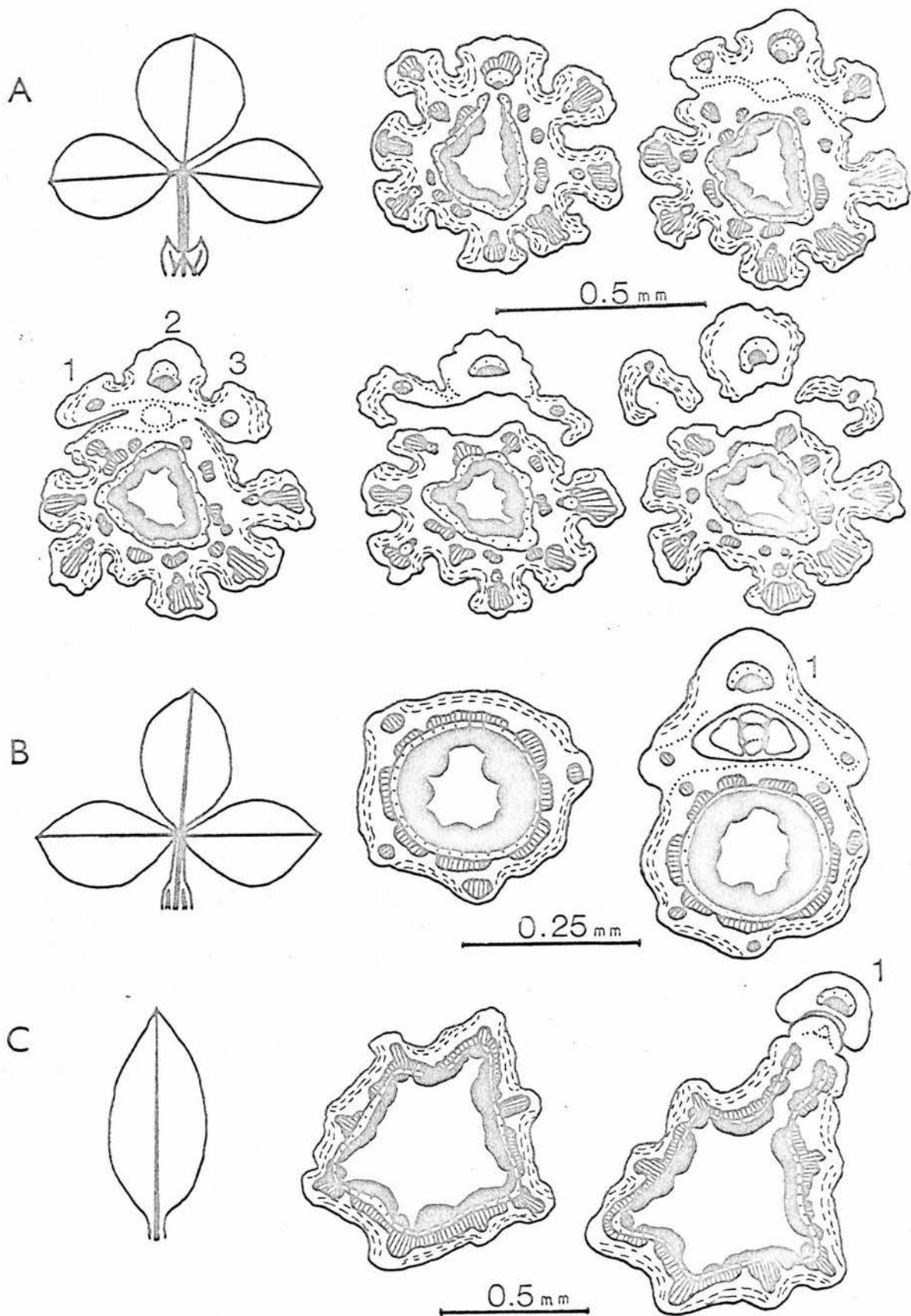


FIG.1

Figs. 2 (D - G) and 3 (overleaf, H - K)

Nodal anatomy in Genista, Cytisus and Teline species:
transverse sections of the stem, through the internode
and node (source material is indicated in brackets)

D G. tinctoria (cultivated specimen)

E C. patens (Spain, Valacloche, V. 1893, Reverchon 585,
MANCH)

F C. tribracteolatus (Spain, Cadiz, La Barrùs, 25. V. 1919,
Son, MA 60637)

G C. perezii (Hutchinson, K)

H (overleaf) C. proliferus (Tenerife, 'in sylvaticis mon-
tanum', 24. III. 1855, Bourgeau 1306, MA 60807)

I T. stenopetala (La Palma, Monte Enrique, 23. IV. 1946,
Ceballos & Ortuno, MA 60727)

J T. spachiana (cultivated, V. 1927, Sennen & Secondaire, LD)

K T. microphylla (Gran Canaria, Cumbre, Roque del Saucillo,
1901, Bornmüller, LD)

FIG. 2

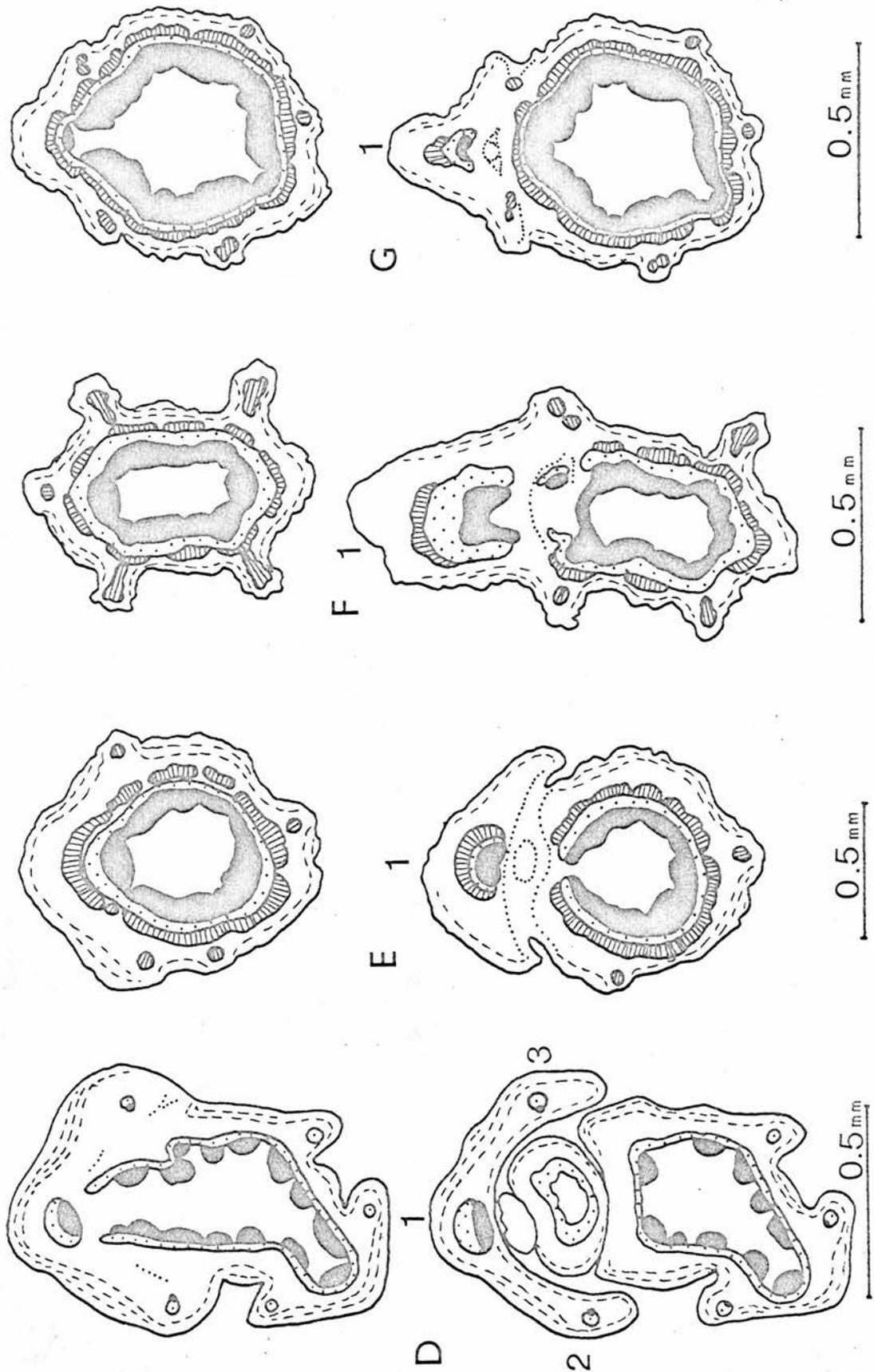
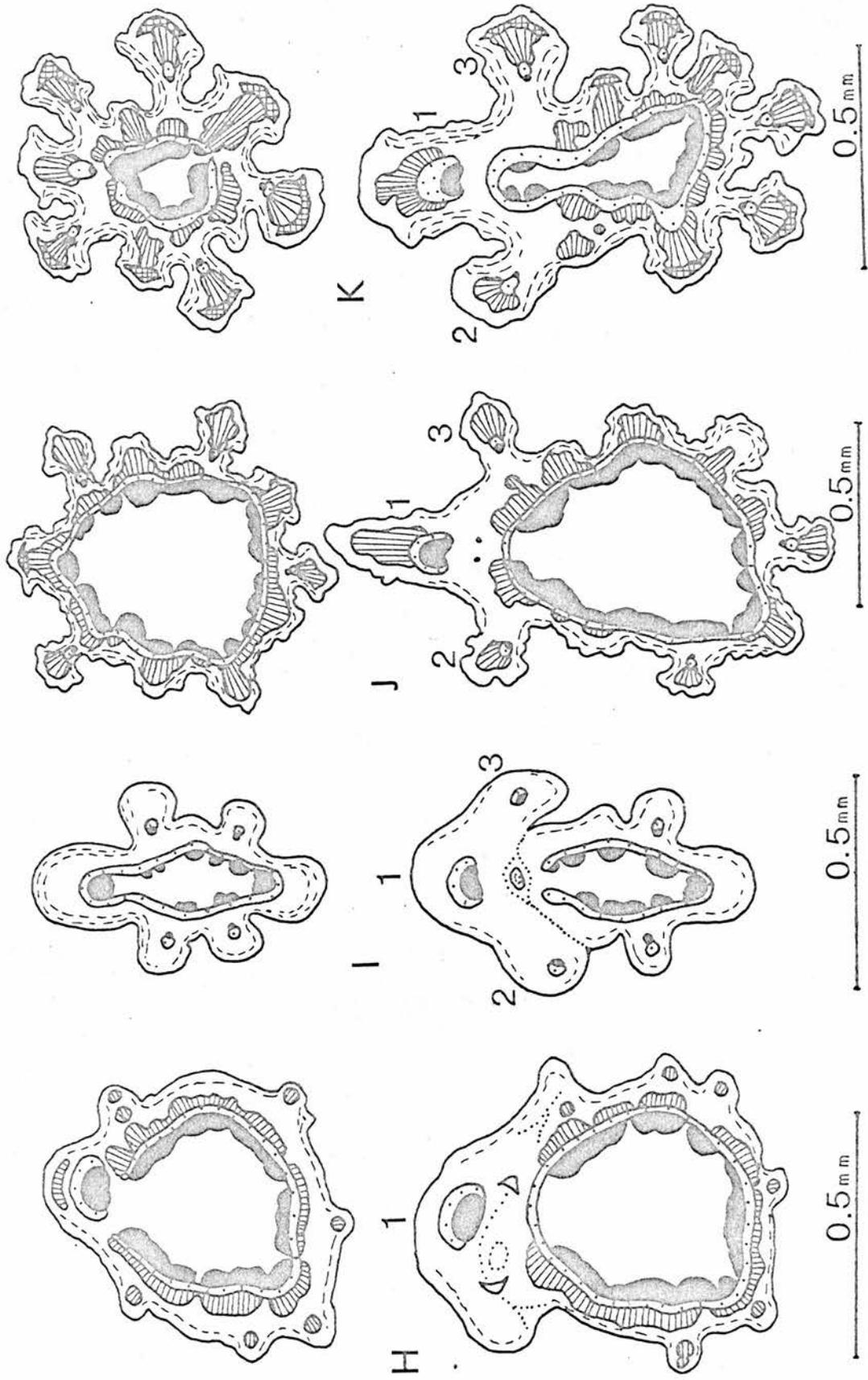


FIG. 3



Figs. 4 (L - O) and 5 (overleaf, P - R)

Nodal anatomy in Teline species: transverse sections of the stem, through the internode and node (source material is indicated in brackets)

- L T. paivae (Madeira, 1865, Lowe 163, COI)
- M T. maderensis (Madeira, Boaventura, Torrinhas, Bornmüller 455, LD)
- N T. monspessulana (Corsica, Rugliano, 20. VI. 1894, Gad-
oceanu, COI)
- O T. linifolia subsp. linifolia (France, Carqueiranes, 1861, Schultz 634, MANCH)
-
- P (overleaf) T. linifolia subsp. pallida (La Palma, Convalle del Rio, 1843, Webb, K)
- Q T. linifolia subsp. rosmarinifolia (Gran Canaria, El Risco Blanco Tiraxana, 1846, Bourgeau 399, MANCH)
- R T. osmariensis (Morocco, Tetuan, Monte Beni Hosmar, 1827, Webb, K)

FIG. 4

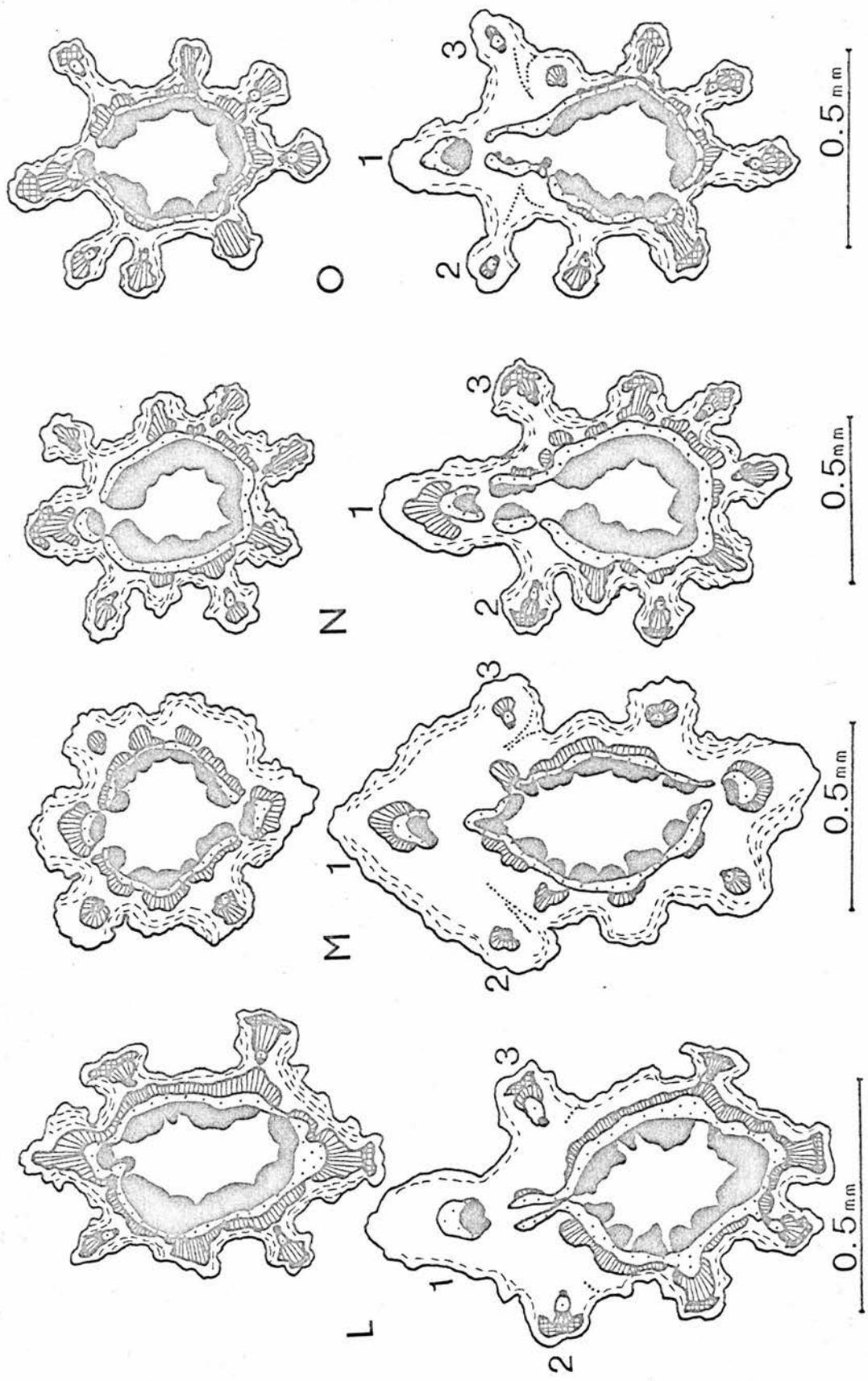
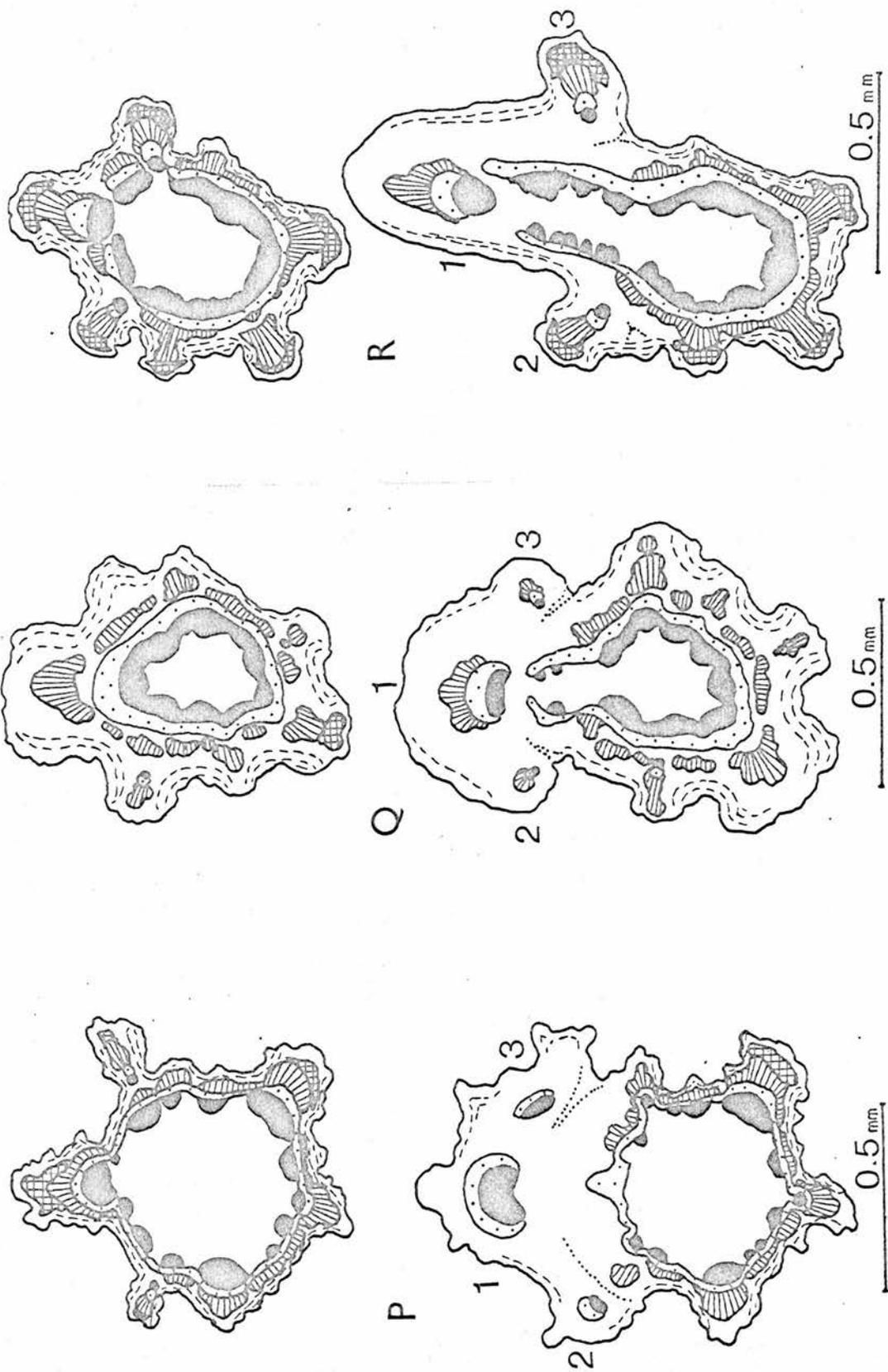


FIG. 5



ii) Leaf insertion

Pellegrin (loc. cit.) found that in Genista and Teline the leaf is inserted opposite an existing ridge in the stem, whereas in Cytisus the leaf is inserted between ridges or angles. Unfortunately this character is inapplicable where the stem is terete, but in the present investigation all the species had angular or ridged stems:

Leaf inserted opposite
a stem angle or ridge

G. hispanica
G. tinctoria
G. januensis
G. pilosa
G. radiata
G. salzmannii
G. aetnensis
G. lobelii
T. monspessulana
T. canariensis
T. ramosissima
T. maderensis
T. stenopetala
T. microphylla
T. linifolia
T. rosmarinifolia
G. spachiana
G. paivae
G. osmariensis

Leaf inserted between
stem angles or ridges

C. sessilifolius
C. purpureus
C. scoparius
C. albus
C. ardoinii
C. patens
C. tribracteolatus
C. perezii
C. proliferus
C. palmensis

iii) Presence of stipules and stipule anatomy

The presence or absence of stipules is not a diagnostic character for the genera Genista and Cytisus; however, Teline species usually have stipules which are well-developed and always contain a vascular trace, whereas in Cytisus, stipules if present never contain vascular tissue and are always inconspicuous. Likewise in Genista, although here they sometimes contain small vascular traces, the stipules are usually inconspicuous.

<u>Stipules</u> <u>absent</u>	<u>Stipules</u> <u>present</u> <u>no vascular</u> <u>tissue</u>	<u>Stipules</u> <u>present</u> <u>little vasc-</u> <u>ular tissue</u>	<u>Stipules</u> <u>present</u> <u>large vascular</u> <u>traces</u>
<u>G. anglica</u>	<u>G. lobelii</u>	<u>G. aetnensis</u>	<u>T. monspessulana</u>
<u>G. hispanica</u>	<u>G. salzmannii</u>	<u>G. tinctoria</u>	<u>T. canariensis</u>
<u>G. radiata</u>	<u>C. ardoinii</u>	<u>T. linifolia</u>	<u>T. ramosissima</u>
<u>G. januensis</u>	<u>C. albus</u>	var.	<u>T. maderensis</u>
<u>C. sessilifolius</u>	<u>C. scoparius</u>	<u>angustifolia</u>	<u>T. stenopetala</u>
<u>C. purpureus</u>		W. & B.(part)	<u>T. microphylla</u>
<u>C. hirsutus</u>			<u>T. linifolia</u> var.
<u>T. linifolia</u> var.			<u>latifolia</u> W. & B.
<u>angustifolia</u>			<u>G. spachiana</u>
W. & B.(part)			<u>G. paivae</u>
<u>T. rosmarinifolia</u>			<u>G. osmariensis</u>
<u>C. patens</u>			
<u>C. tribracteolatus</u>			
<u>C. perezii</u>			
<u>C. proliferus</u>			
<u>C. palmensis</u>			

2. Morphology

i) Calyx upper lip

Several authors (eg. Spach, 1845) have laid emphasis on the shape of the calyx upper lip in their taxonomy of Teline with respect to the genera Genista and Cytisus. In Genista and Teline the calyx upper lip is deeply bifid, whereas in Cytisus it is entire or only slightly cleft. In the present study both types were found:

Upper lip deeply cleft

G. hispanica
T. monspessulana
T. canariensis
T. ramosissima
T. maderensis
T. stenopetala
T. microphylla
T. linifolia
T. rosmarinifolia
G. spachiana
G. paivae
G. osmariensis
C. patens

Upper lip entire or only slightly cleft

C. sessilifolius
C. tribracteolatus
C. perezii
C. proliferus
C. palmensis

ii) Keel petal shape

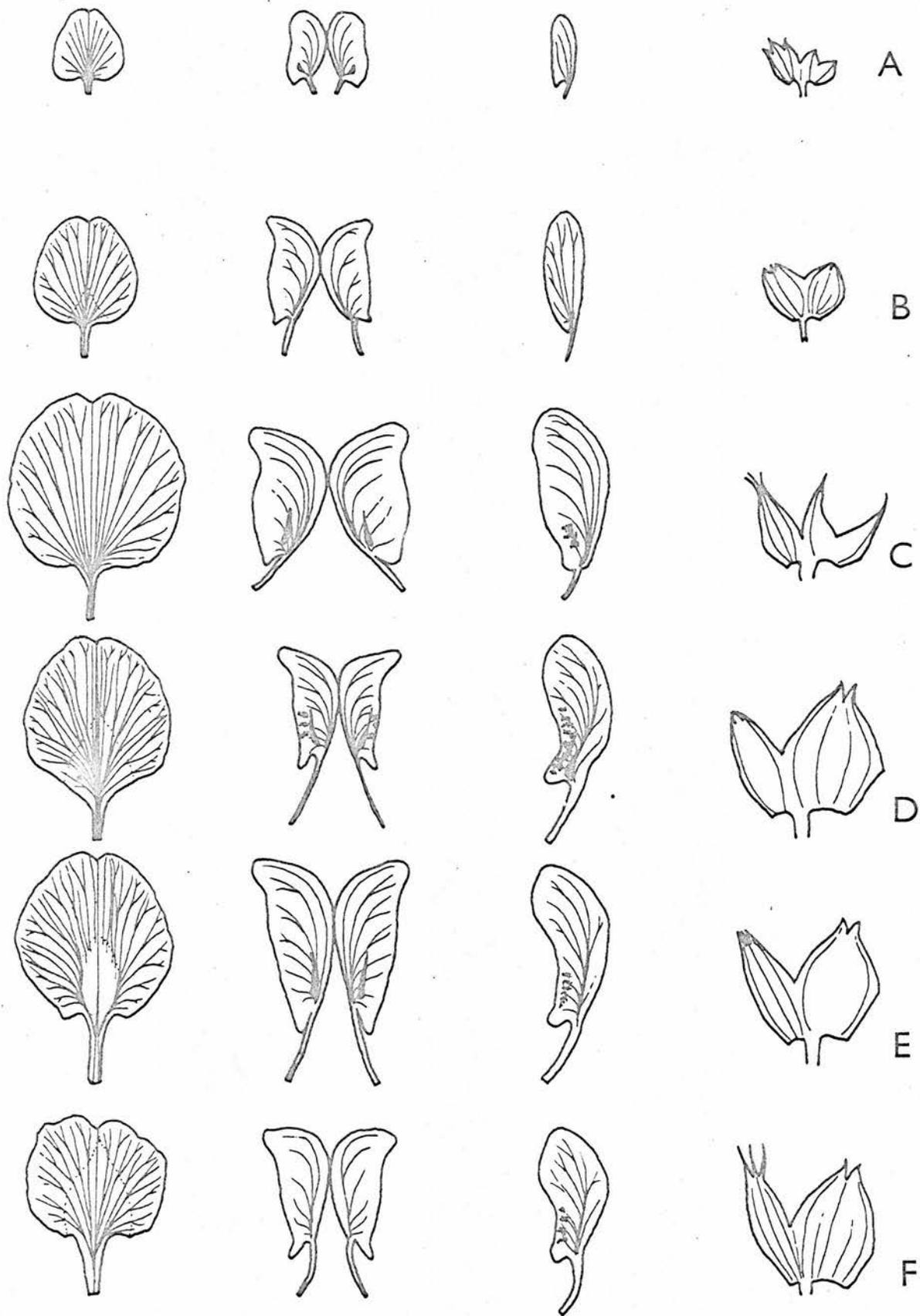
Webb and Berthelot (1842), Spach (1845) and Gibbs (1966) have shown that Genista and Teline species have an oblong keel petal whereas Cytisus species have a markedly falcate keel petal.

Fig. 6: Illustrations of the corolla in Genista and
Cytisus species (source material for floral
dissections is indicated in brackets)

- A G. hispanica (cultivated specimen)
- B C. sessilifolius (cultivated specimen)
- C C. patens (Spain, Valacloche, V. 1893, Reverchon 585
MANCH)
- D C. perezii (Hutchinson, K)
- E C. proliferus (Tenerife, 'in sylvaticis montanum',
24. III. 1855, Bourgeau 1306, MA60307)
- F C. palmensis (Tenerife, La Matanse, Asplund, K)

Illustrations A - T (Figs. 6, 7 and 8) are all at 2x
natural size.

FIG. 6



Figs. 7 (G - M) and 8 (overleaf, N - T):

Illustrations of the corolla in Cytisus and Teline species

(source material for corolla dissections is indicated in brackets)

- G C. tribracteolatus (Spain, Algeciras, IV. 1849, Reuter, K)
- H T. canariensis (Tenerife, Santa Cruz, Broussonet, MA 60722)
- I T. stenopetala (Hierro, Mocanal, 21. V. 1901, Bornmüller 2186, LD)
- J T. spachiana (cultivated, Tenerife, Jardim d'Acclimatacion, Puerto Orotava, 9. III. 1912, Perez, K)
- K T. microphylla (Gran Canaria, Cumbre, Roque del Saucillo, Bornmüller 466, LD)
- L T. paivae (Madeira, 1865, Lowe, K)
- M T. maderensis (Madeira, Ribeiro Frio, VI. 1862, Clarke, K)
- N (overleaf) T. monspessulana (Algeria, Oran, Forêt de M'Sila, D'Alizette, LD)
- O T. linifolia subsp. rosmarinifolia (Gran Canaria, El Risco Blanco Tiraxana, 1846, Bourgeau 399, MANCH)
- P T. linifolia subsp. teneriffae (Tenerife, Taganana, 'in rupestribus altioribus sylvae', VI. 1846, Bourgeau 572, MANCH)
- Q T. linifolia subsp. gomeræ (Gomera, El Cumbre, Hermigua, 19. IV. 1861, Lowe 183G, K)
- R T. linifolia subsp. pallida (La Palma, Convalle del Rio, 1843, Webb, K)
- S T. linifolia subsp. linifolia (France, Carqueiranes, 1861, Schultz 634, MANCH)
- T T. osmariensis (Morocco, Tetuan, Monte Beni Hosmar, 1827, Webb, K)

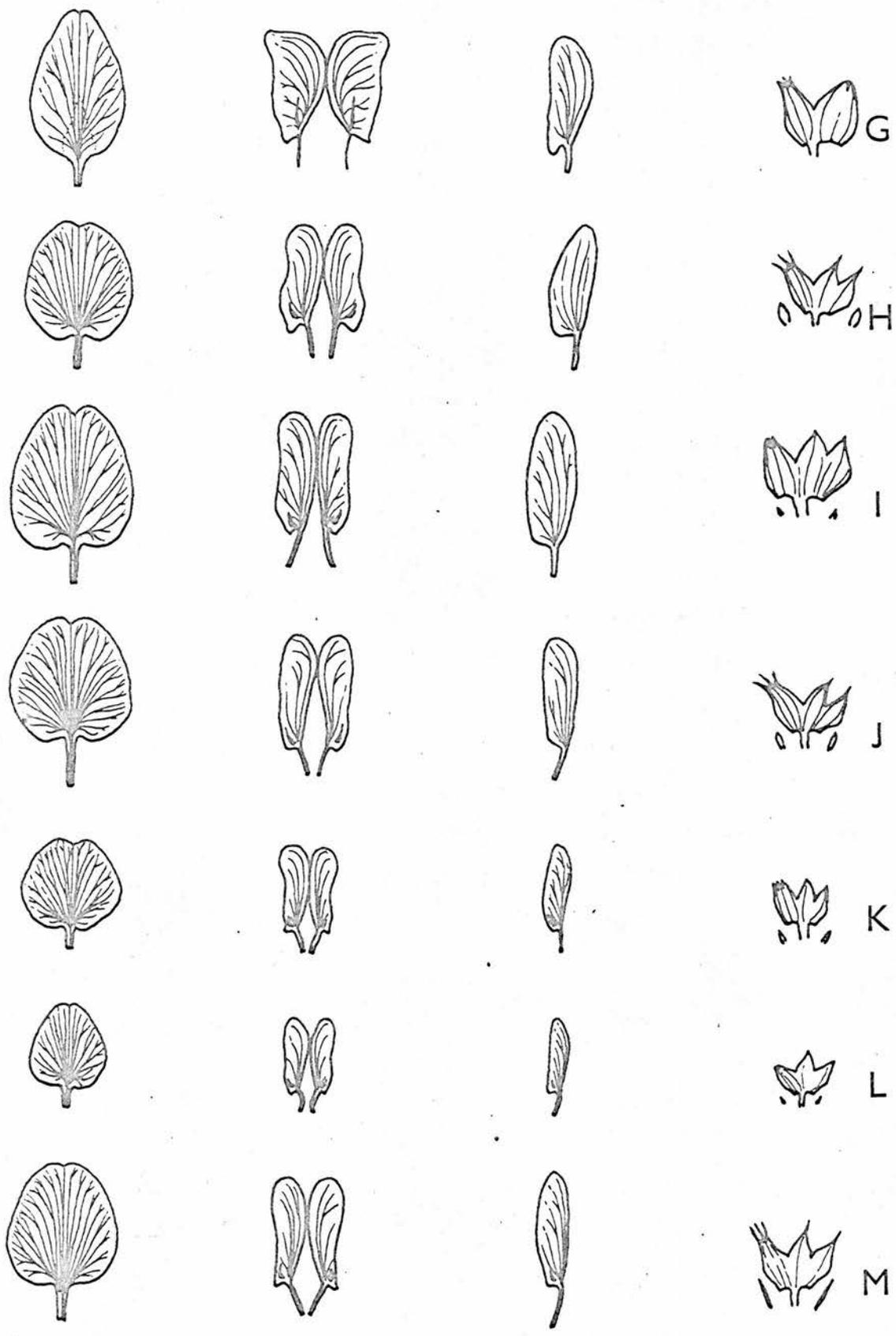
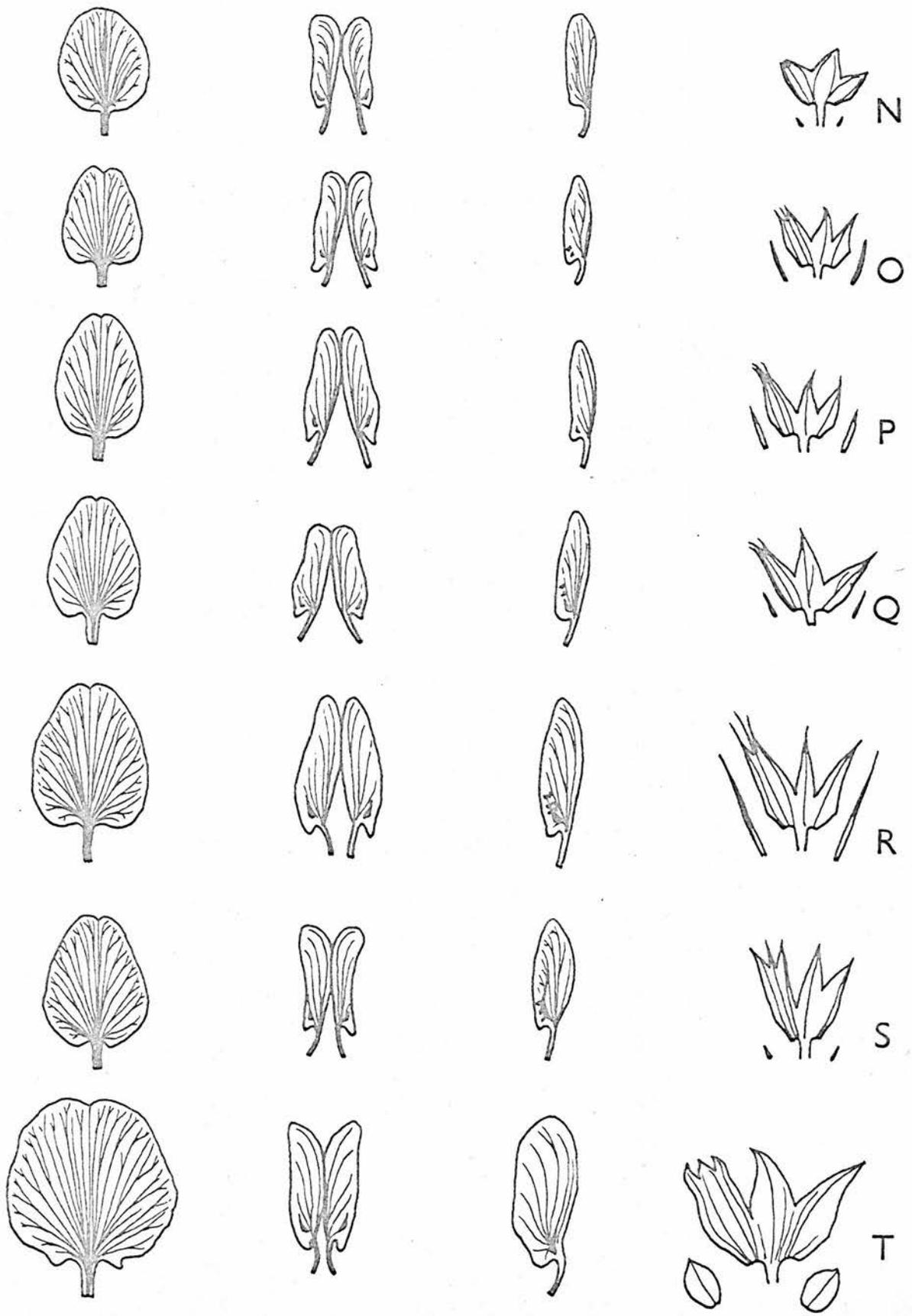


FIG. 7

FIG. 8



Keel petal oblong

G. hispanica
T. monspessulana
T. canariensis
T. ramosissima
T. maderensis
T. stenopetala
T. microphylla
T. linifolia
T. rosmarinifolia
G. spachiana
G. paivae
G. osmariensis

Keel petal falcate

C. sessilifolius
C. patens
C. tribracteolatus
C. perezii
C. proliferus
C. palmensis

iii) Seed strophiole

The presence or absence of a strophiole on the seed is perhaps the most widely recognised diagnostic character for Genista and Cytisus, eg. Bentham (1862) placed Teline in the genus Cytisus since both taxa have strophiolate seeds, whereas in Genista the seeds are estrophiolate. No seeds of G. osmariensis were available; all the other species were found to have strophiolate seeds.

iv) Leaf foliolation

According to Gibbs (1966), about four-fifths of Genista species have unifoliolate leaves. A similar proportion of Cytisus species, and all Teline species, have trifoliolate leaves.

Leaves unifoliolate

G. tinctoria
G. januensis

Leaves trifoliolate

G. radiata
C. purpureus

Leaves unifoliolate

G. pilosa
G. lobelii
G. salzmannii
G. anglica
G. hispanica
G. aetnensis
G. sagittalis
C. scoparius
 (upper leaves)

Leaves trifoliolate

C. scoparius (lower leaves)
C. sessilifolius
C. hirsutus
C. albus
C. ardoinii
C. patens
C. tribracteolatus
C. perezii
C. proliferus
C. palmensis
T. monspessulana
T. canariensis
T. ramosissima
T. maderensis
T. stenopetala
T. microphylla
T. linifolia
T. rosmarinifolia
G. spachiana
G. paivae
G. osmariensis

v) Leaf petiole

Gibbs (1966) has found that in Genista species the leaves are sessile or sub-sessile, whereas in most Cytisus and Teline species they are petiolate:

Leaves sessile

G. januensis
G. anglica
G. hispanica

Leaves sub-sessile

G. tinctoria
G. pilosa
G. lobelii

Leaves petiolate

C. sessilifolius (most)
C. ardoinii
C. hirsutus

<u>Leaves sessile</u>	<u>Leaves sub-sessile</u>	<u>Leaves petiolate</u>
<u>C. tribracteolatus</u>	<u>G. salzmannii</u>	<u>C. albus</u>
<u>T. linifolia</u> var.	<u>G. radiata</u>	<u>C. scoparius</u> (most)
<u>angustifolia</u>	<u>C. sessilifolius</u>	<u>C. purpureus</u>
W. & B. (part)	(few)	<u>C. patens</u>
<u>T. rosmarinifolia</u>	<u>C. scoparius</u> (few)	<u>C. perezii</u>
	<u>T. linifolia</u> var.	<u>C. proliferus</u>
	<u>angustifolia</u>	<u>C. palmensis</u>
	W. & B. (part)	<u>T. monspessulana</u>
		<u>T. canariensis</u>
		<u>T. ramosissima</u>
		<u>T. maderensis</u>
		<u>T. stenopetala</u>
		<u>T. microphylla</u>
		<u>T. linifolia</u> var.
		<u>latifolia</u> W. & B.
		<u>G. spachiana</u>
		<u>G. paivae</u>
		<u>G. osmariensis</u>

vi) Inflorescence

According to Briquet (1894), in subsections Cephaloteline and Phylloteline of sect. Teline, the inflorescence is a terminal head or raceme (indeterminate and pseudo-umbellate in the case of T. monspessulana), whereas in Pleuroteline the flowers are borne laterally, in the axils of leaves. Genista species usually have terminal inflorescences, but sometimes the flowers are axillary, as they are in Cytisus species. In the present study all three types were found:

<u>Flowers in terminal heads or racemes</u>	<u>Flowers in lateral heads, pseudo-umbellate</u>	<u>Flowers lateral, in the axils of leaves</u>
<u>G. hispanica</u>	<u>T. monspessulana</u>	<u>C. sessilifolius</u>
<u>G. tinctoria</u>		<u>C. patens</u>
<u>T. canariensis</u>		<u>C. tribracteolatus</u>
<u>T. ramosissima</u>		<u>C. perezii</u>
<u>T. maderensis</u>		<u>C. proliferus</u>
<u>T. stenopetala</u>		<u>C. palmensis</u>
<u>T. microphylla</u>		
<u>T. linifolia</u>		
<u>T. rosmarinifolia</u>		
<u>G. spachiana</u>		
<u>G. paivae</u>		
<u>G. osmariensis</u>		

Conclusion

In the light of the above investigation, three distinct groups exist:

- 1) leaves with three vascular traces at the node, the leaf inserted opposite a ridge in the stem; stipules usually present and well-developed (absent in part of T. linifolia var. angustifolia W. & B. and in T. rosmarinifolia), always trifoliolate, calyx upper lip deeply cleft; keel petal oblong; seeds strophiolate; flowers in terminal or lateral heads or racemes, never axillary:- Teline sensu Webb and Berthelot (1842) including also G. spachiana Webb (1845), G. paivae Lowe (1868) and G. osmariensis Coss. (1873).
- 2) leaves with one or three vascular traces at the node,

without lateral fibrous traces, the leaf inserted opposite a ridge in the stem; stipules small or absent; leaf usually sessile or subsessile and unifoliolate; calyx upper lip deeply cleft; keel petal oblong; seeds estrophiolate; flowers usually in terminal heads or racemes:- Genista.

3) leaves with one vascular and two fibrous traces at the node, the leaf inserted between the ridges in the stem; stipules small or absent (never containing vascular tissue); leaf usually petiolate and trifoliolate; calyx upper lip entire or only slightly bifid (except in C. patens); keel petal markedly falcate; seeds strophiolate; flowers axillary:- Cytisus, including C. tribracteolatus, C. proliferus, C. perezii, C. palmensis and C. patens.

Of the species studied, only C. patens presented an anomalous situation: like Teline and Genista species, C. patens has a deeply cleft calyx upper lip. However, since it differs from Teline in several other characters (exstipulate leaves with only one vascular trace, which is inserted between ridges in the stem, a falcate keel petal and flowers in the axils of leaves, resembling Cytisus) it is considered preferable to retain C. patens in the genus Cytisus.

The investigation demonstrates that Teline is as readily distinguishable from Genista as it is from Cytisus. In addition, no record of hybridisation between species of Teline and species of Genista or Cytisus has been found. It is therefore preferable to recognise Teline as a distinct genus; the present account follows Medikus (1787), Webb and Berthelot (1842) and Gibbs (1966, 1968) in doing so.

SECTION II

RELATIONSHIPS WITHIN THE GENUS

RELATIONSHIPS WITHIN THE GENUS

At the present time, T. linifolia and T. monspessulana are widespread in the Mediterranean region; the other species of the genus all have rather restricted distributions, occurring on only one or two Atlantic islands or in the case of T. osmariensis on one mountain in Morocco.

Little geological data has been found concerning the Canary Islands, where the majority of species occur, but it has been established that the islands are of early Tertiary origin. The islands Gran Canaria, Tenerife, Gomera, La Palma and Hierro are wholly formed of igneous rock; however on the two islands closest to the mainland, Fuerteventura and Lanzarote, the igneous rock is merely a thin covering over a basically sedimentary foundation. Fossils found in the latter strata provide conclusive evidence of a land-bridge connecting these two islands to the mainland at the time of the Tertiary orogeny. The genus, which may be assumed to have originated on the mainland, could have spread to the archipelago via this connection; although at the present time there are no Teline species on Fuerteventura or Lanzarote, this is probably because of the arid conditions on these islands. Such a land-bridge could possibly have extended to Madeira, which is also on the African continental shelf although further from the mainland, but not to the Azores¹, which

¹T. monspessulana is found on the Azores but is thought to have been introduced by Portuguese settlers since the seeds are not sea-borne and it is unlikely that they would be carried to such a distance by birds.

Map 1: Distribution of the genus Teline

|||| Area occupied by the genus

--- Limits of T. monspessulana

.....Limits of T. linifolia

....Limits of Macaronesian species (6)

○ Limits of T. osmariensis

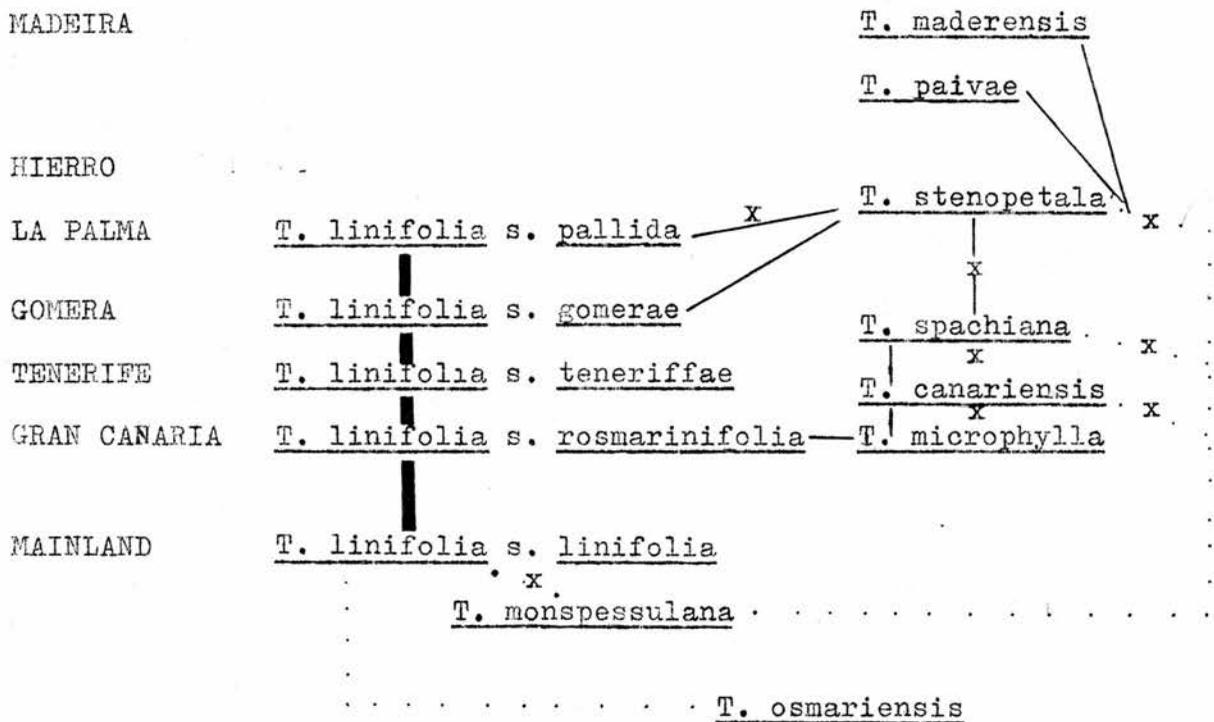
are oceanic and far more remote.

In the open, non-competitive environment of recently formed land, adaptation to local condition variations could have occurred rapidly. Subsequent fragmentation of the land-bridge into an archipelago, thus restricting gene exchange and increasing the probability of random genetic drift in small island populations, could effect a rapid proliferation of species which, although they are morphologically distinct, appear to be very closely related.

Several east-west character trends (eg., increase in leaflet, petiole and corolla length) shown by different T. linifolia subspecies are paralleled in other Canary Island species. This might suggest that two migrant taxa evolved in a linear fashion as they migrated from east to west, the one giving rise to the T. linifolia subspecies and the other to the species T. microphylla - T. canariensis - T. spachiana - T. stenopetala (- T. maderensis - T. paivae: Madeira). It is also apparent that of the T. linifolia subspecies, T. linifolia subsp. linifolia resembles Canary Island species least, whereas subsp. rosmarinifolia shows striking similarities to T. microphylla¹, and other subspecies all resemble Canary Island species in some way. This suggests that only one ancestral taxon migrated from the mainland, diverging on Gran Canaria into two species lines. An arrangement of species with

¹Early in the study it was suggested that T. linifolia subsp. rosmarinifolia could be a hybrid between subsp. linifolia and T. microphylla; this idea was rejected because it is not completely intermediate, and because subsp. linifolia does not occur on the islands.

regard to morphological similarity and distribution reflects these suggestions:



(x: intermediates, some only in cultivation; very close morphological affinity; .. little affinity.)

Several hypotheses concerning the nature of the original migrant taxon or taxa can be put forward:

1) Simultaneous speciation on both mainland and islands may have occurred. However, in Teline the mainland species are much more distinct than the island species, which suggests that those on the mainland are older and were possibly in existence at the time of colonisation of the newly formed land. Also, since T. linifolia

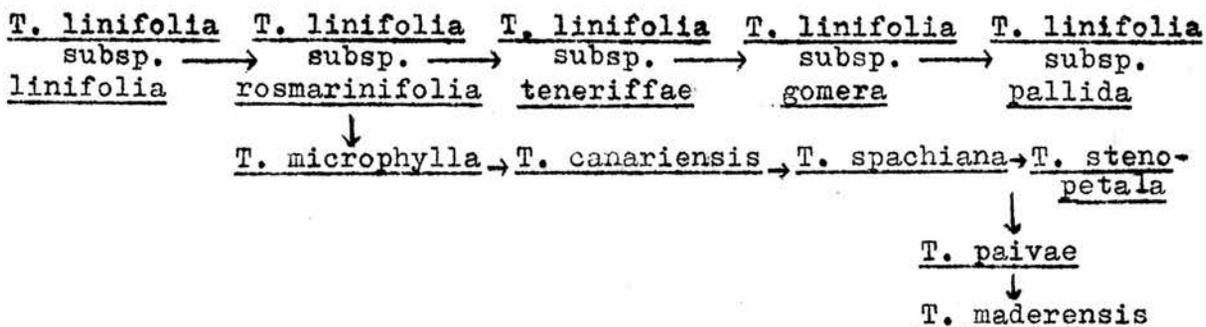
has representatives on both mainland and islands, it can be argued that at least this species was already in existence at the time of colonisation.

2) At the time of migration, it is possible that T. monspessulana, T. linifolia and a now extinct precursor species existed on the mainland; T. linifolia and the precursor species could have migrated to the islands, evolving into new T. linifolia subspecies on the one hand and the present-day island species on the other. In this case, the resemblance of subsp. rosmarinifolia to T. microphylla is surprising. No trace of an ancestral species is now evident, unless T. osmariensis can be considered as such; however this is a most distinct species which shows less affinity with Canary Island species than with T. monspessulana or T. linifolia and is therefore unlikely to be the immediate ancestor of the Macaronesian species.

3) T. monspessulana and/or T. linifolia may have migrated to the islands from the mainland, there developing into the T. microphylla-maderensis group and the linifolia subspecies. T. monspessulana is a somewhat unlikely forbear for the island species since it has lateral inflorescences whereas in the Macaronesian species the inflorescence is always terminal. The lateral inflorescence persists in hybrids of T. monspessulana with other species and even in segregates away from T. monspessulana. It is improbable that such a persistent character would be completely lost if T. monspessulana were the ancestral species. The fact that it hybridises with Canary Island species in cultivation is perhaps

indicative of affinity, but it is to be remembered that T. monspessulana also hybridises (though rarely) with T. linifolia subsp. linifolia although these two species are very distinct. T. monspessulana does however occur in the Canary Islands, having an apparently relic distribution on Tenerife, so that the possibility of its being the ancestor of the present-day island species cannot be discounted.

T. linifolia is possibly a more likely ancestral species than T. monspessulana. The existence of both island and mainland subspecies suggests that a linifolia-like taxon must have migrated to the Canaries, and the resemblance of T. linifolia subsp. rosmarinifolia to T. microphylla suggests that the island species and subspecies could have evolved in the following way:



However, present-day distribution and morphology of the species, although they make possible some suggestions as to the history of the genus, do not supply conclusive evidence for these hypotheses. Three other methods of investigation, comparative anatomy, cytology and biochemistry, might throw some light on the history of the

group. Anatomical studies on the stem have shown no significant differences between species, and none have been reported in the literature. As to cytology, all species studied are reported to have a chromosome number of $2n=48$ ¹ and a detailed comparison of the chromosomes would entail a major investigation. With regard to comparative biochemistry, a study of this genus is being carried out in Liverpool but the results of this investigation are not yet known.

Intermediates between species of Teline

Cultivated material of the Atlantic Island species appears to contain a high proportion of intermediate individuals and it is probable that many of the species hybridise freely when they occur together. In nature however the species are generally distinct and there are few intermediates from natural localities, primarily because most species are geographically isolated. Specimens intermediate between the following species have been seen:

T. linifolia subsp. linifolia and T. monspessulana (2)²

T. linifolia subsp. pallida and T. stenopetala (1)

T. monspessulana and T. canariensis (2)

? T. canariensis and T. stenopetala = T. spachiana (2, + 6
cultivated at Orotava, Tenerife)

¹T. canariensis and T. monspessulana are reported to have $2n=46$ as well as $2n=48$ (T. canariensis = 46, 48, Santos, 1945; T. monspessulana = 46, 48, de Castro, 1949) in Darlington and Wylie (1955).
²Figures in brackets refer to numbers of specimens seen from natural localities.

T. canariensis and T. spachiana (? some)

T. canariensis and T. microphylla (several)

Only in the last three cases is the proportion of intermediate pure specimens significant and these are discussed below.

T. spachiana and T. paivae are also included since, although there are no intermediate specimens, these species are somewhat similar.

1) T. canariensis and T. microphylla

In general, herbarium specimens of these species suggest that although 'typical' T. canariensis and T. microphylla differ in several respects, there are a few intermediates which cannot easily be referred to either species. This is supported by scatter diagrams (Figs. 9 and 10) plotted for various parameters. These demonstrate that although in most single characters the range for each species overlaps the other, pairs of characters consistently produce the same two groups and the same intermediates. Differences between the two taxa are listed below:

	<u>T. canariensis</u>	<u>T. microphylla</u>
Leaflet length/width ratio	1.3-2.0 (-3) mm.	1.7-3.3 mm.
Petiole length	1.0-2.0 mm.	1.2-3.2 mm.
Petiolule length	0.2-0.5 mm.	0.0-0.2 mm.
Leaflet shape	slightly involute	markedly involute, appearing linear
Calyx shape	teeth long, acuminate	teeth short, acute
Pedicel length	1.5-3.0 mm.	1.0-1.7 mm.
Inflorescence length	10-50 mm.	5-20 mm.

Map 2: Distribution of T. canariensis and

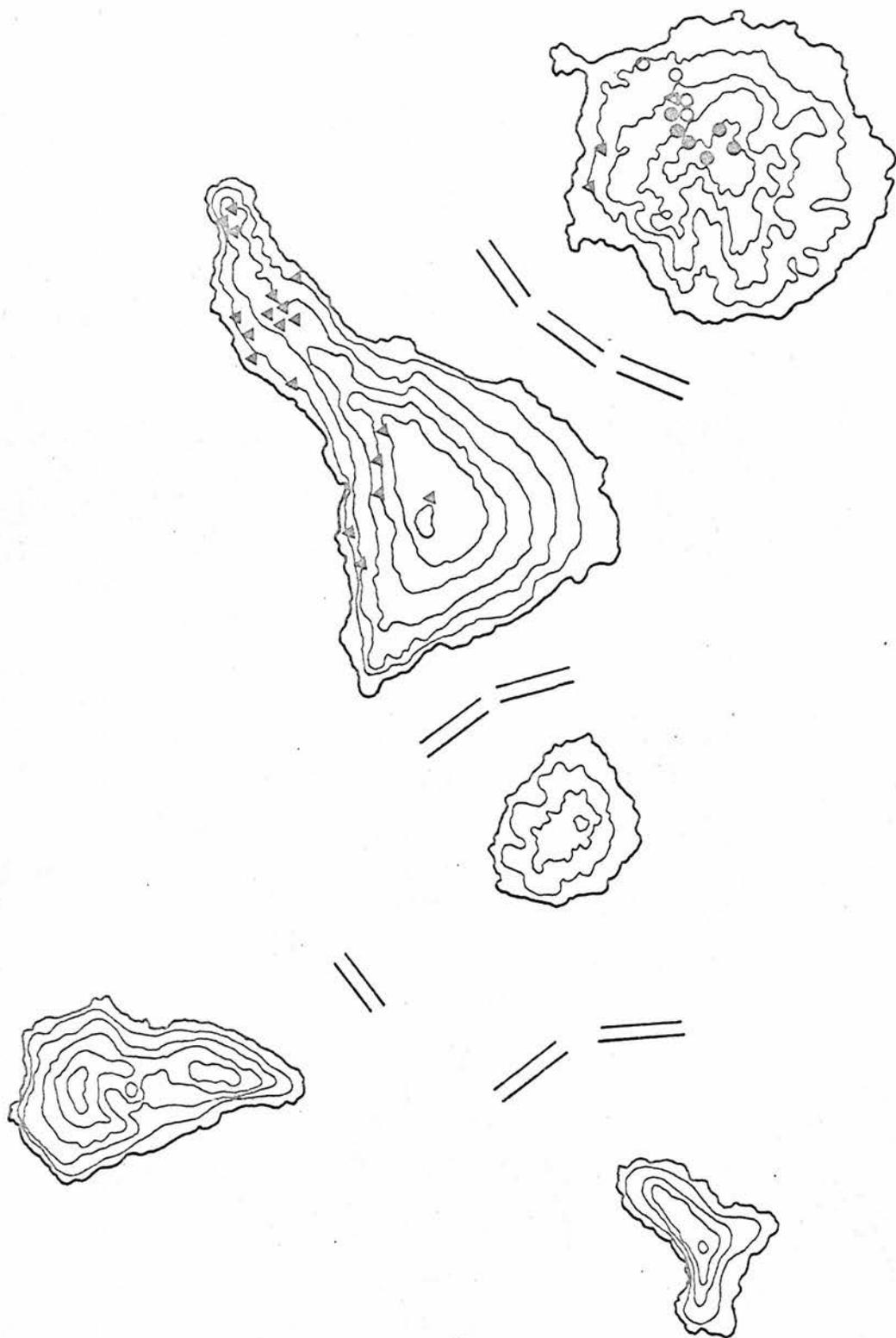
T. microphylla

▲ 'typical' T. canariensis

● 'typical' T. microphylla

△ completely intermediate

○ intermediate, but closer to T. microphylla
than to T. canariensis



MAP 2

(cont'd)	<u>T. canariensis</u>	<u>T. microphylla</u>
Indumentum of stems and leaves	softly adpressed to patent pubescent	densely tomentose to patent pubescent
Indumentum of standard petal	broad (to narrow) sericeous V	line of hairs at apex, to narrow V

Very few specimens of T. canariensis from Gran Canaria have been seen but there is no evidence to suggest that this species has been transferred from Tenerife after European colonisation. T. canariensis was first cited from Gran Canaria by Webb and Berthelot (1842) and from the evidence must be considered as naturally distributed on this island. The intermediates however may be of relatively recent origin since previous authors have not mentioned any difficulties in distinguishing between the two species. It is of interest in this context that the two most recently collected specimens (Frey and Stora, 1931, and Trethewy, 1933) are also the most intermediate¹: specimens collected eg. by Bourgeau (1846) show the distinguishing characters of the two taxa more clearly. The hypothesis of relatively recent origin of the intermediates, by hybridisation, is also supported by the following evidence: they have generally been collected from localities along the Barranco de la Angostura, which runs from the Cumbres near the Roque del Saucillo to Las Palmas. The Barranco is also the route

¹Evidence of this type should naturally be used with caution, when the longevity of such shrubby plants is considered: a plant from which Webb and Berthelot took specimens could still be living in 1930 when Frey and Stora collected material. However in this case the specimens are from different localities.

Fig. 9: Scatter diagrams demonstrating correlation of characters in T. microphylla and T. canariensis

- | | |
|-----------------------------------|-----------------------------------------------------------------------------------|
| ● 'typical' <u>T. microphylla</u> | ▲ 'typical' <u>T. canariensis</u> |
| △ completely intermediate | ○ intermediate, but closer to <u>T. microphylla</u> than to <u>T. canariensis</u> |

Fig. 9 A: Leaflet length/width ratio (X axis) and petiolule length (Y axis)

- Standard petal with line of hairs along midvein
- Standard petal with narrow V-shaped pubescent area
- Standard petal with broad V-shaped pubescent area
- Calyx teeth short, acute
- Calyx teeth intermediate
- Calyx teeth long, acuminate

Fig. 9 B: Leaflet/petiole length ratio (X axis) and inflorescence length (Y axis)

- ● ● as in Fig. 9 B
- Leaflets very strongly involute
- Leaflets somewhat involute
- Leaflets very slightly involute at the margins

FIG. 9

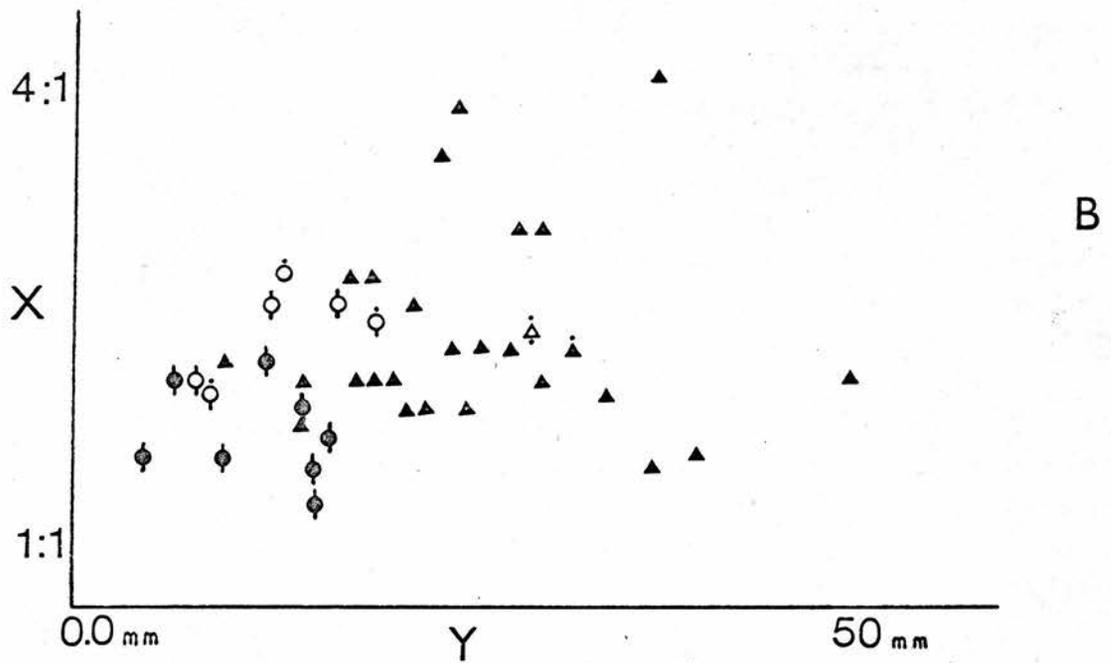
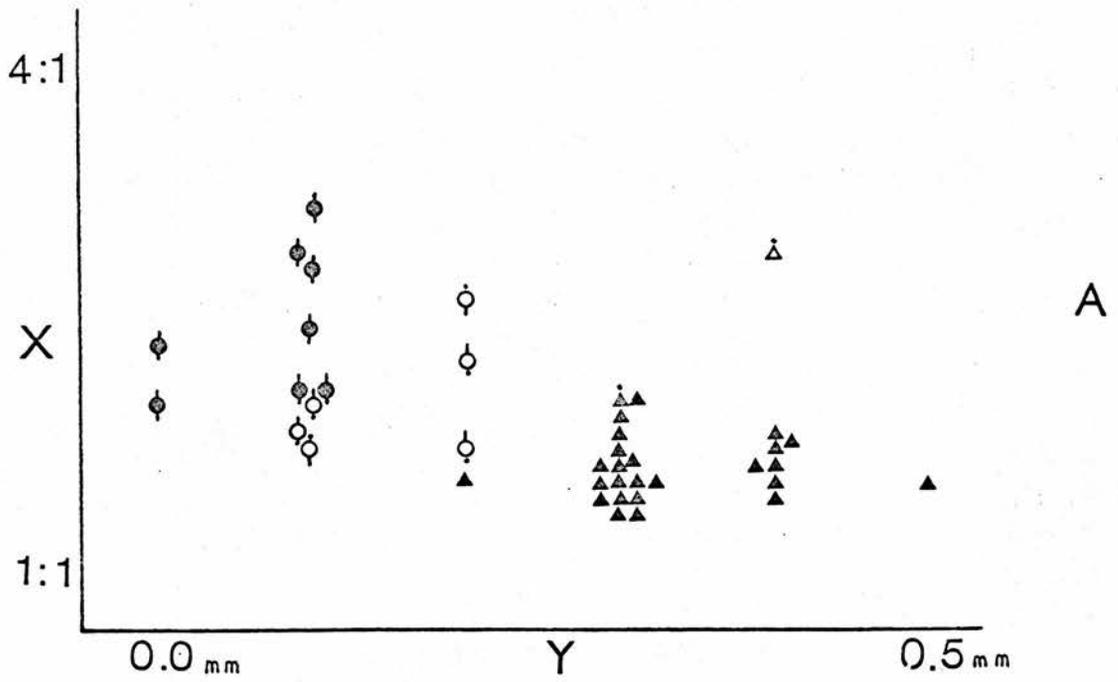


Fig. 10: Scatter diagrams demonstrating correlation of characters in T. microphylla and T. canariensis (cont'd.)

- 'typical' T. microphylla ▲ 'typical' T. canariensis
△ completely intermediate ○ intermediate, but closer
to T. microphylla than
to T. canariensis

C: Leaflet length/width ratio (X axis) and pedicel length (Y axis)

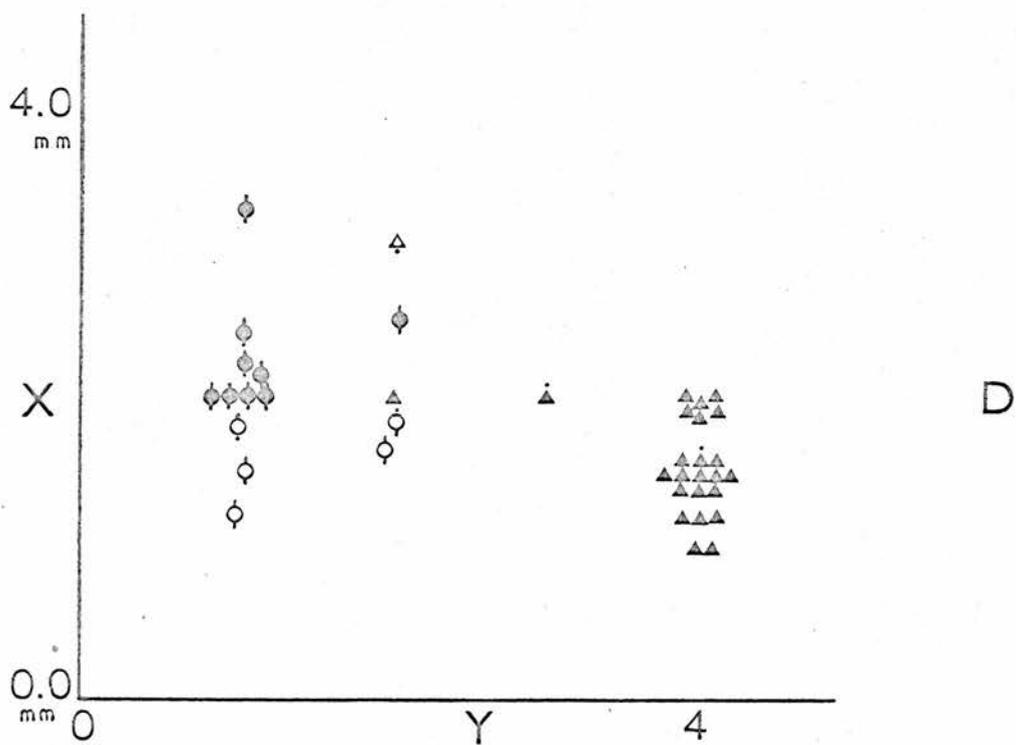
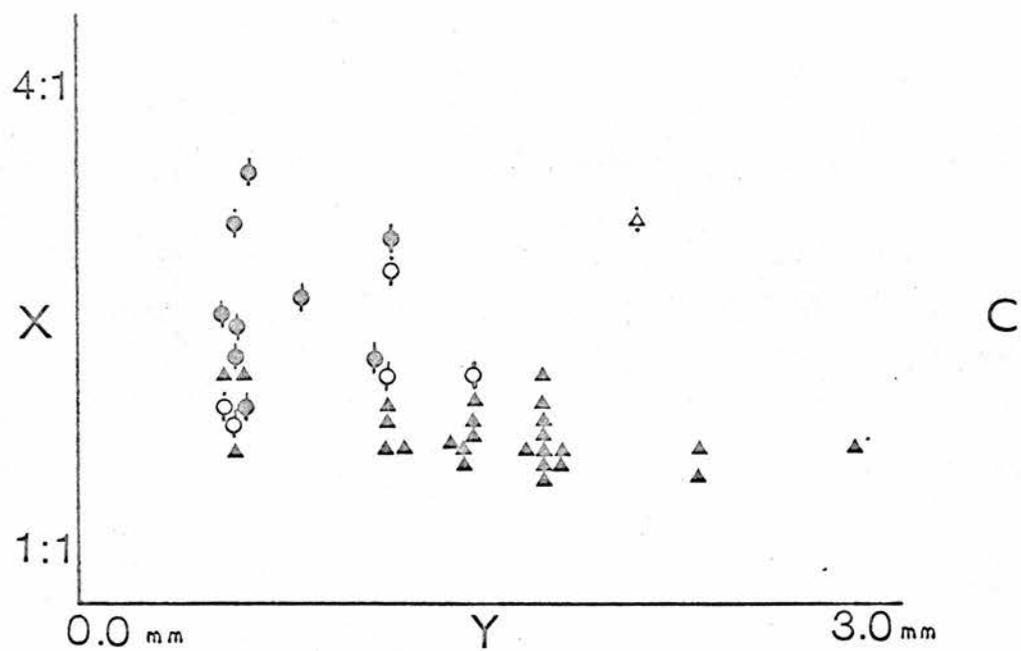
- Standard petal with line of hairs along midvein
- Standard petal with narrow V-shaped pubescent area
- Standard petal with broad V-shaped pubescent area
- Leaflets very strongly involute
- Leaflets somewhat involute
- Leaflets very slightly involute at the margins

D: Petiole length (X axis) and standard petal indumentum (Y axis, from line of pubescent hairs to broad V-shaped pubescent area)

●●● as in 10 C.

- Petiolule 0.0-0.1 mm.
- Petiolule 0.2 mm.
- Petiolule 0.3 mm. or more

FIG.10



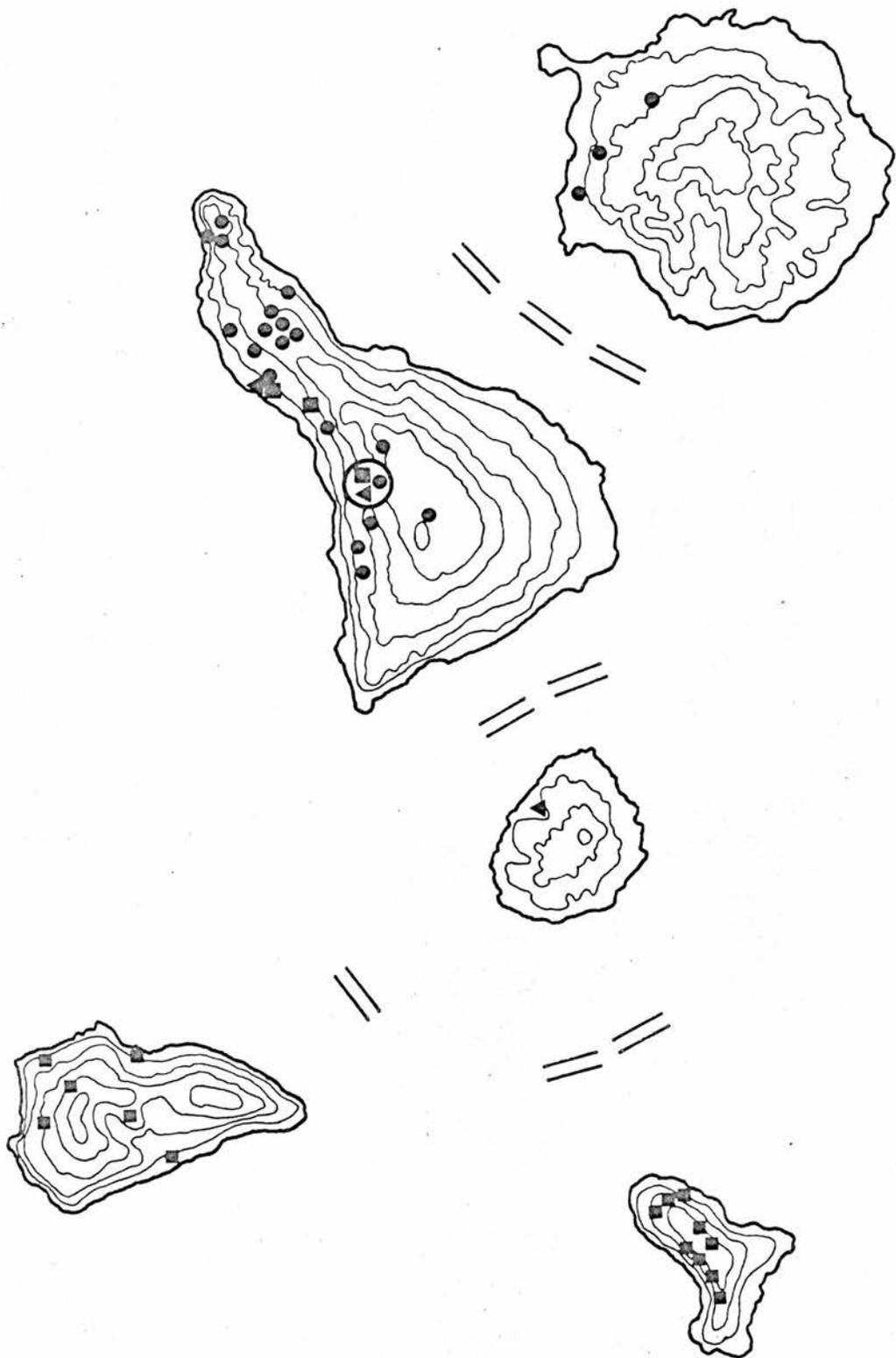
of the principal road on the island and of the system transporting water from near the Roque del Saucillo to Las Palmas. Thus the activities of man may have destroyed old habitats and created disturbed areas in which hybrids between T. microphylla from the Cumbres and T. canariensis from the lower coastal areas could survive. It appears that these easily accessible localities have been over-collected by more recent collectors in comparison to the more remote area of the Cumbres, where 'pure' T. microphylla is reported (1969) to be growing in profusion.

2) T. canariensis - T. stenopetala - T. spachiana

Specimens of T. spachiana from natural localities (or from plants cultivated from seed collected in natural localities) are few; nevertheless this species is of great interest since in general appearance it is intermediate between T. canariensis and T. stenopetala. Scatter diagrams (figs. 11 and 12) of various characters which are diagnostic for T. stenopetala and T. canariensis also demonstrate the intermediacy of T. spachiana. They show a complete gradation between 'typical' T. canariensis and T. spachiana which makes the selection of diagnostic characters for these two species almost impossible. This intergradation is most obvious when more recently collected specimens are compared. Specimens of T. spachiana from natural localities, the description of the species given by Webb and the accompanying drawing in the Botanical Magazine (1845) differ from specimens of T. canariensis collected by Webb in having

Map 3: Distribution of T. canariensis, T. stenopetala
and T. spachiana

- T. canariensis ■ T. stenopetala
- ▲ T. spachiana



MAP 3

Figs. 11 and 12 (overleaf): Scatter diagrams demonstrating correlation of characters in T. canariensis, T. stenopetala and T. spachiana

● T. canariensis ■ T. stenopetala ○ T. spachiana

- 11 A: Bracteole length (X axis) and leaflet length (Y axis) △ cultivated specimens
- Standard petal with a broad V-shaped pubescent area
 - Standard petal with a narrow V-shaped pubescent area
 - Standard petal glabrous or slightly puberulent along the midvein
- 11 B: Leaflet length (X axis) and petiole length (Y axis)
- Petiolule 0.6 mm. or more ○ Petiolule 0.5 mm.
 - Petiolule 0.4 mm. or less
- 12 C (overleaf): Petiole length (X axis) and leaflet/stipule length ratio (Y axis)
- Leaflet length/width ratio 2.6 or more
 - Leaflet length/width ratio 2.1-2.5
 - Leaflet length/width ratio 2.0 or less
- 12 D (overleaf): Bracteole length (X axis) and standard petal length (Y axis)
- Standard petal with a broad V-shaped pubescent area
 - Standard petal with a narrow V-shaped pubescent area
 - Standard petal glabrous or slightly puberulent along the midvein

FIG. 11

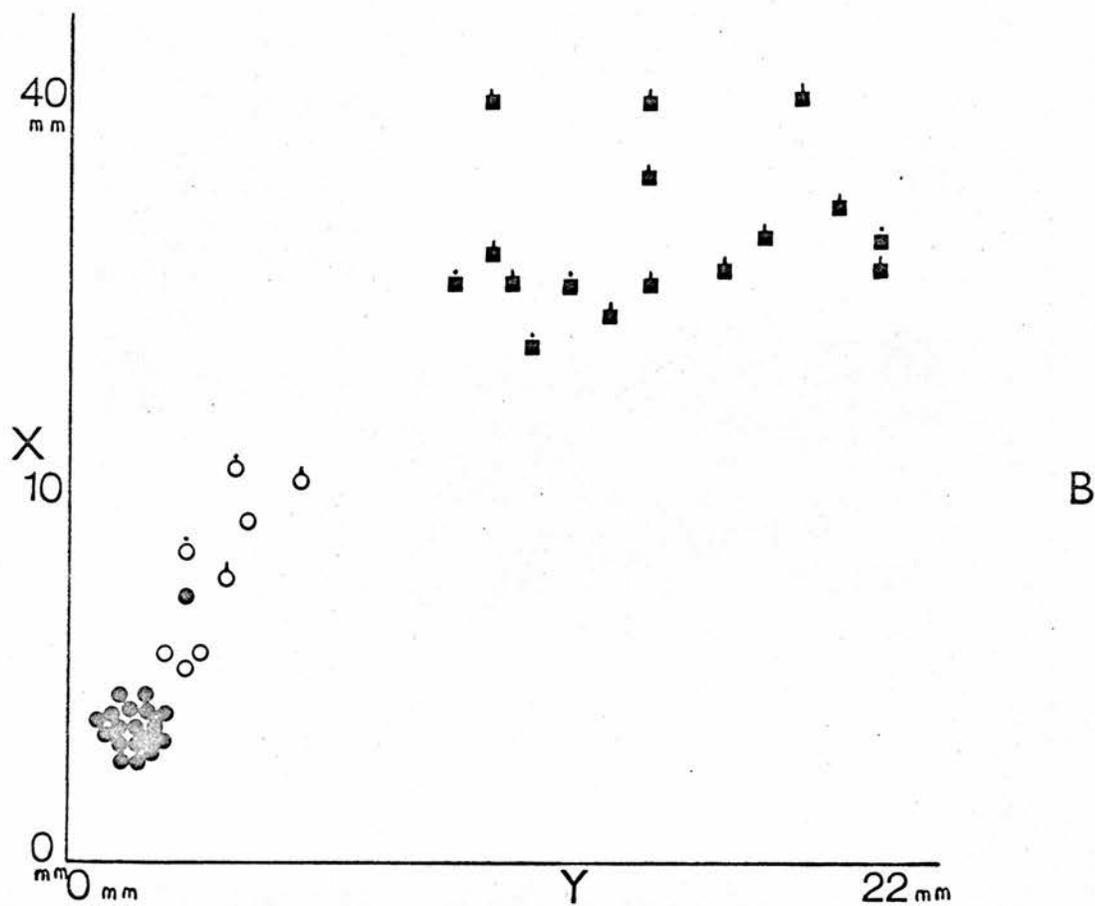
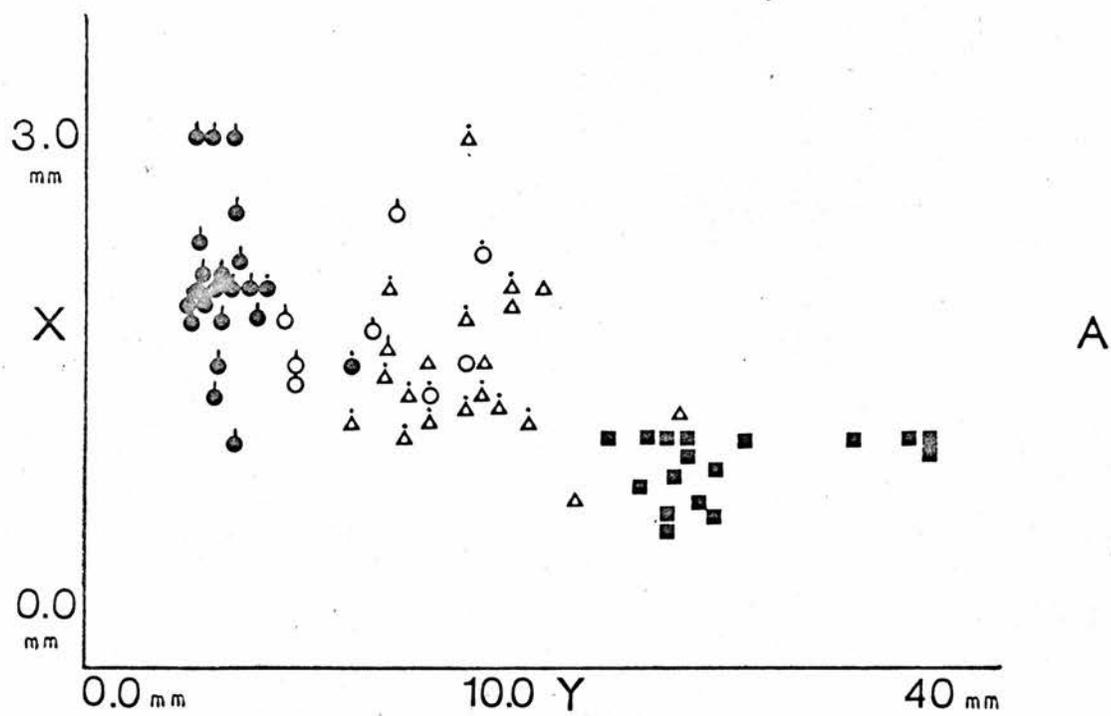
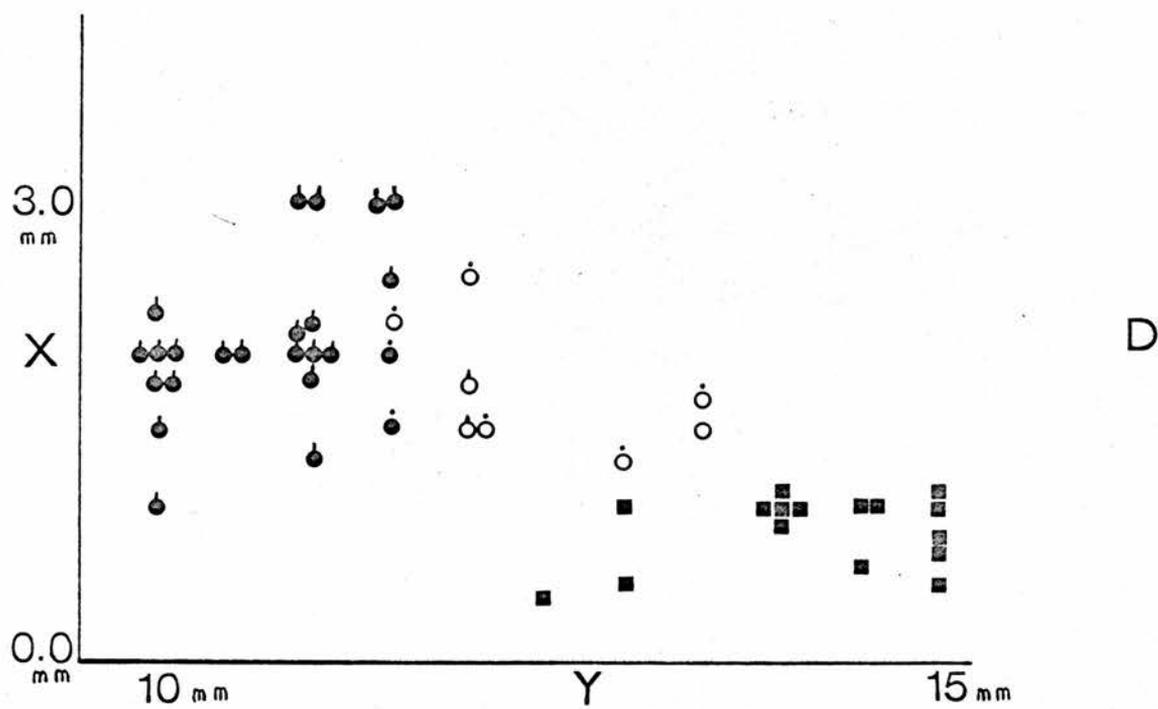
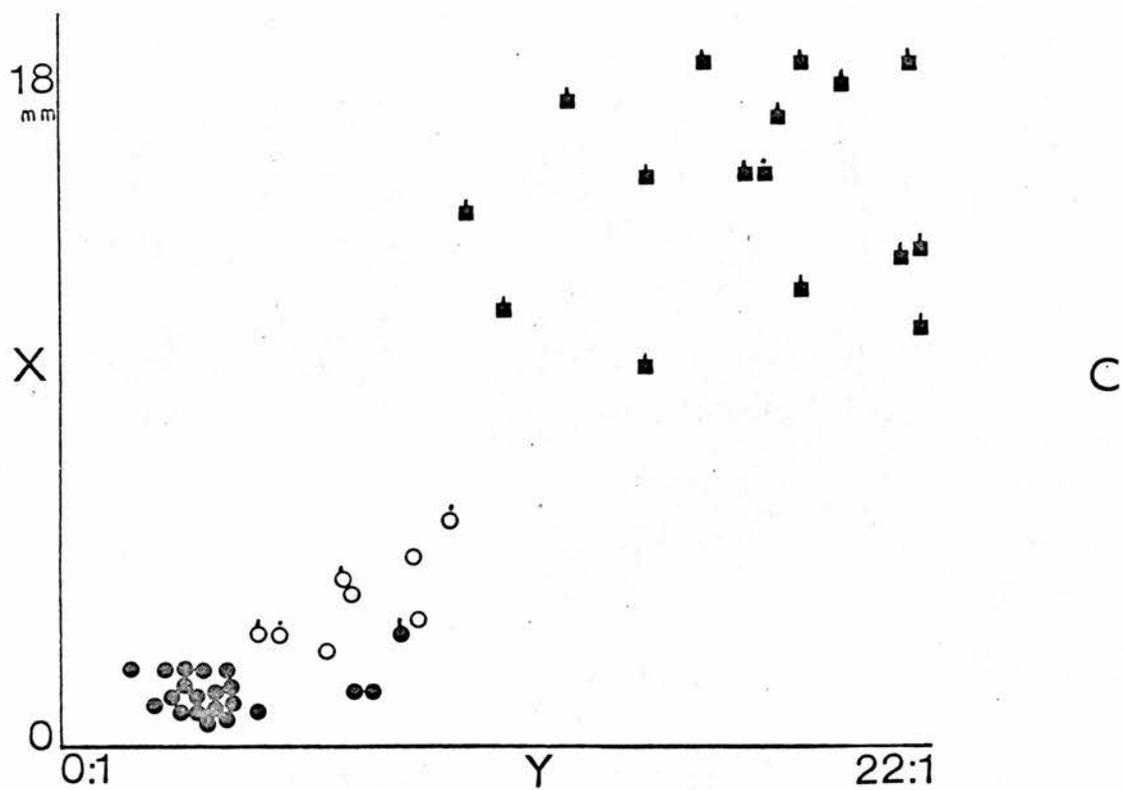


FIG.12



longer leaflets and petioles, and shorter, more linear bracteoles. These differences are not so apparent when T. spachiana is compared with more recently collected material of T. canariensis, the latter sometimes having leaflets of up to 6-7 mm. in length. This suggests that these intermediate specimens are hybrid rather than that T. spachiana and T. canariensis are imperfectly differentiated species. Admittedly the differences between older and more recently collected specimens could also be explained by some change in habitat conditions, but no report of such a change has been seen.

A similar gradation between T. spachiana and T. stenopetala is found when cultivated material is investigated, but there is a clear discontinuity between specimens of these two species from natural localities only. Thus they would seem to be interfertile in cultivation, but in natural habitats they do not generally occur together.

The apparent interfertility shown by T. spachiana with both T. stenopetala and T. canariensis, together with its intermediacy, suggests that it is itself possibly a hybrid of these two species. This appears feasible on the island of Tenerife: T. canariensis is naturally distributed on this island and has been reported by all authors, but T. stenopetala is believed to have been introduced via the Jardim d'Acclimatacion at Puerto Orotava (see p. 54). This garden is known to have been in existence at the time of Webb and Berthelot's visit to the Canary Islands, ca. 1836, and probably

for some time before that date. Thus native T. canariensis could have hybridised with T. stenopetala, either growing in the garden or escaped, to produce the intermediate T. spachiana which was first described by Webb in 1845. Back-crossing to T. canariensis might have resulted in some larger-leaved plants of the latter species collected by subsequent botanists. This theory is not practicable when it is known that T. spachiana also exists on Gomera, where neither of the putative parent species occur. It is however possible that the naturally occurring intermediate species T. spachiana, from Gomera, has been simulated by the hybridisation of T. stenopetala and T. canariensis on Tenerife. Only the recent establishment of T. spachiana on this island, whether by such a hybridisation or by introduction from Gomera, would explain why two (albeit ill-defined) entities exist on Tenerife although T. canariensis and T. spachiana appear interfertile and have no known ecological preferences. This is a situation which only further collections on these islands and hybridisation studies can clarify.

The Anderson hybrid index technique was carried out using both natural and cultivated material, in an attempt to demonstrate (1) the intermediacy of T. spachiana between T. stenopetala and T. canariensis; (2) the discontinuity between T. spachiana and T. stenopetala from natural localities; (3) the 'overlap' between T. spachiana and T. canariensis and the proportion of intermediate specimens. The following characters were used in calculating the hybrid index:

	<u>T. canariensis</u>	<u>T. spachiana</u>	<u>T. stenopetala</u>
Leaflet length	3 - 5 mm.	5 - 15 mm.	19 - 45 mm. ¹
Leaflet length/ width ratio	1.3-2.0:1	2.0-2.7:1	2.5-4.6:1
Petiole length	1 - 2 mm.	2.5 - 6.0 mm.	10 - 21 mm.
Inflorescence length	15 - 50 mm.	30 - 120 mm.	35 - 140 mm.
Pedicel length	1.0 - 2.5 mm.	2 - 4 mm.	2.0 - 4.5 mm.
Bracteole length	1.0 - 3.2 mm.	1.0 - 2.5 mm.	0.4 - 1.0 mm.
Standard petal indumentum	narrow to broad V-shaped pub- escent area	puberulent along mid- vein to narrow or small pubes- cent V	glabrous or slightly pub- erulent along midvein

In the index (fig. 13), T. spachiana falls between T. canariensis and T. stenopetala and the discontinuity between natural T. stenopetala and T. spachiana is also clearly demonstrated. As to the overlap between T. canariensis and T. spachiana, the groups to which specimens were assigned by appearance alone (before detailed investigation) are supported in a more statistical way by the hybrid index, since there is no intermingling of different groups. This is of particular interest in the canariensis - spachiana area because it shows that variation in character is not completely random. The index also demonstrates that of the three

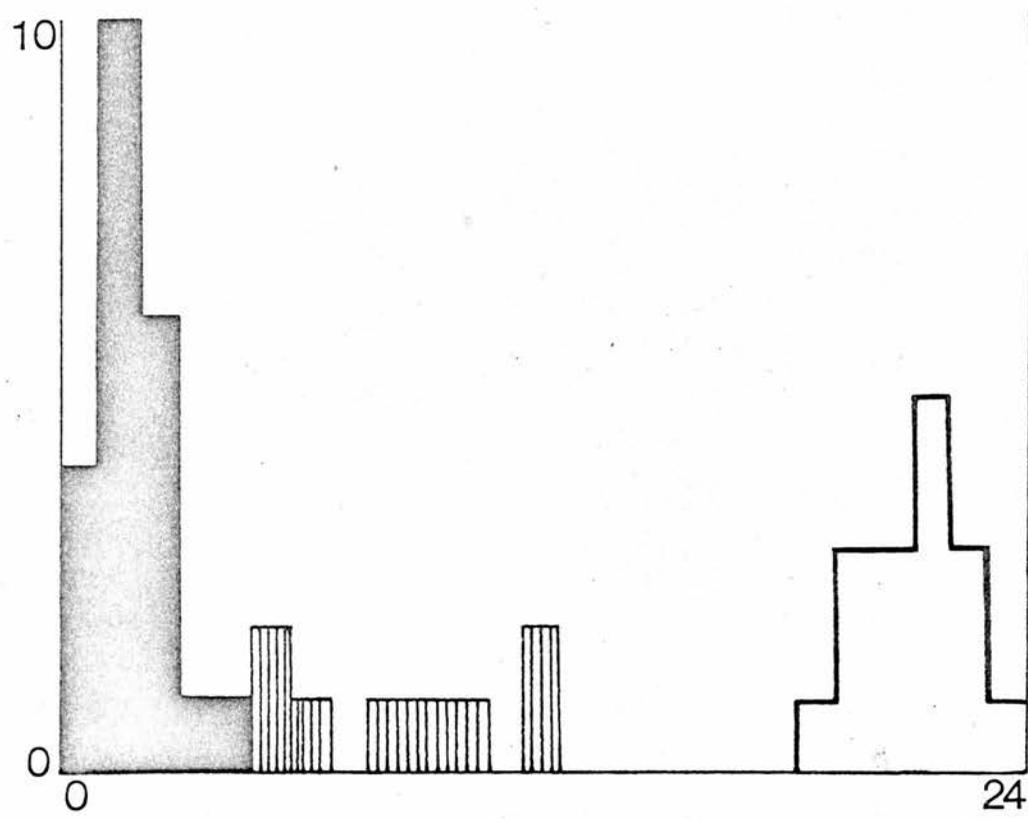
¹These limits were fixed after the situation had been investigated: in the hybrid index work they were fixed arbitrarily, since there was some doubt as to the limits of the species, eg.:
Leaf length below 5 mm., score 0 (T. canariensis); 5.1-10 mm., score 1 (T. spachiana); 10.1-15 mm., score 3 (T. spachiana); over 15.1 mm., score 4 (T. stenopetala). The specimens were grouped by appearance alone into pure T. canariensis (black in the hybrid index histogram), pure T. stenopetala (white) and intermediates (shaded).

Fig. 13: Hybrid indices obtained by using Anderson's technique for T. canariensis, T. stenopetala and T. spachiana, when T. spachiana is considered to be hybrid.

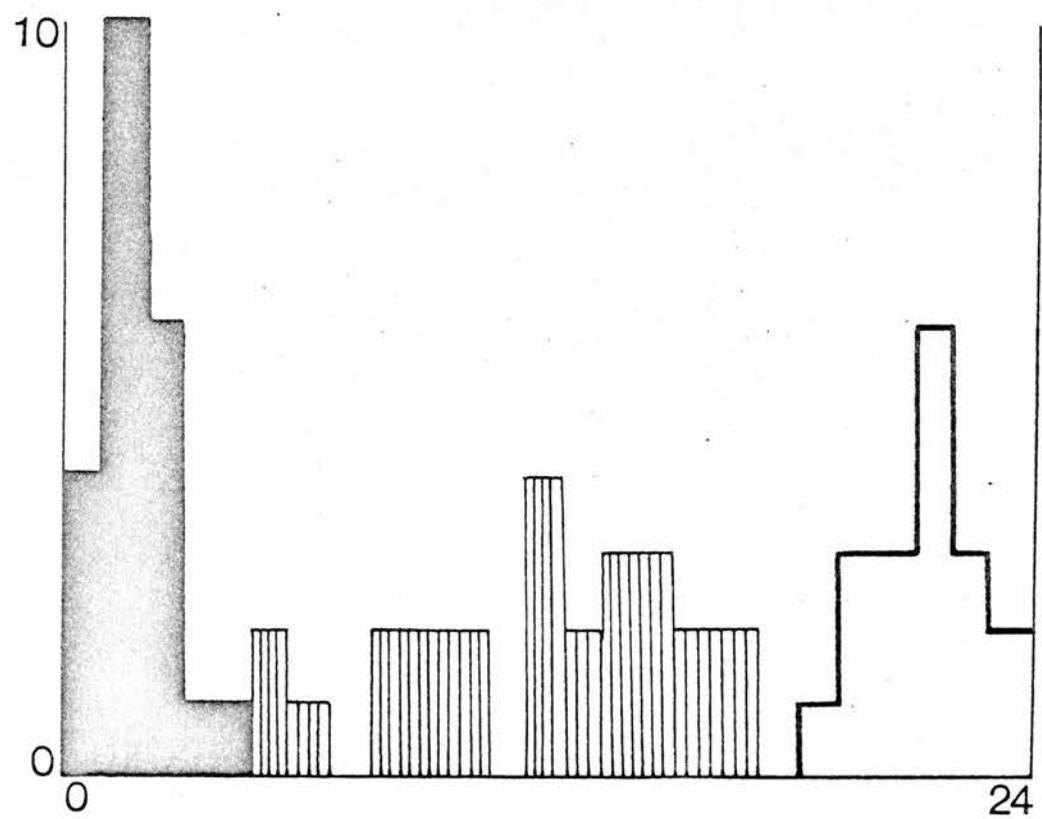
■ T. canariensis □ T. stenopetala
▨ T. spachiana

- A: Specimens from natural localities only
B: Specimens from natural localities and cultivated material

FIG. 13



A



B

species, canariensis and stenopetala form closely knit groups with a high proportion of specimens of each species in a small area of the histogram, whereas specimens between T. canariensis and T. stenopetala (ie. T. canariensis - spachiana intermediates and T. spachiana) show no such concentration and are more spread out. This is perhaps typical of a hybrid population where the F_1 plants are vigorous and fertile among themselves and with the parent species. It becomes clear at any rate that T. spachiana is not such a good species as T. canariensis or T. stenopetala. However, for want of positive evidence of hybridisation in these species, it was thought preferable to retain T. spachiana as a species in the formal part of the revision.

Studies on intermediate Teline specimens from the United States

American specimens of T. canariensis spachiana - stenopetala facies from California appear to have hybridised with T. monspessulana as well. American specimens appearing to contain no monspessulana genome were included in the scatter diagram, fig. 11A, and in the hybrid index, fig. 13B. For the specimens where T. monspessulana was involved, a different method of assessing the parental species had to be employed. A type of hybrid index analogous to the Anderson index was formulated, using pairs of characters in scatter diagrams, that is, the position of a specimen on the scatter diagram was used as a single character. The means for the species T. canariensis, T. stenopetala and T. monspessulana were used as reference points on each scatter

diagram. T. spachiana was not plotted as a further reference point for the following reasons:

- 1) The limits T. canariensis/T. spachiana are debatable, so that calculating the mean for T. spachiana, of which there are few specimens from natural localities, could involve considerable error.
- 2) In the scatter diagrams, T. spachiana is always intermediate between T. canariensis and T. stenopetala and it is impossible to find character pairs in which T. spachiana specimens are as far distant as those of T. nonspessulana are from T. canariensis and T. stenopetala.
- 3) If T. spachiana is a hybrid species, there would be no advantage in plotting its mean as a further reference point.

Nineteen scatter diagrams, employing the fourteen characters listed below, were used in this investigation:

Leaflet length	Corolla length
Leaflet length/width ratio	Floral interval (ie. interval between flowers)
Petiole length	No. of flowers per raceme
Leaflet/stipule length ratio	Floral interval/petiole length ratio ¹
Inflorescence length	Leaflet length/floral interval ratio
Bracteole length	Floral interval/stipule length ratio
Leaflet/petiole length ratio	Inflorescence/petiole length ratio

The percentage of each species in any specimen was then calculated by means of a ratio which is explained fully in the

¹ Several unusual ratios were found to give good scatter diagrams.

Figs. 14 and 15 (overleaf): Populations with hybrids involving three species: triangular graphs obtained using the method described in the appendix

- | | |
|----------------------------------------|-------------------------------------------------|
| ○ <u>T. canariensis</u> | ● <u>T. monspessulana</u> |
| ■ <u>T. stenopetala</u> | ◆ <u>T. spachiana</u> (from natural localities) |
| □ naturalised material from California | ◇ cultivated material from Russia |

A: Specimens from natural localities only

B: Specimens from natural localities and naturalised material from California

C (overleaf): Specimens from natural localities and cultivated material from Europe (◆) and Russia

FIG. 14

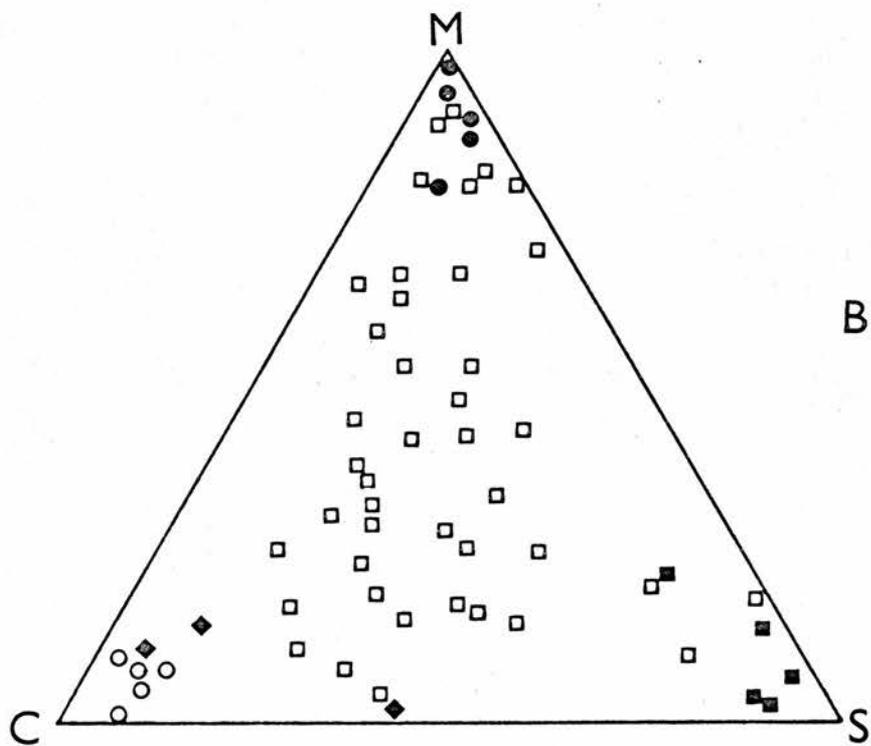
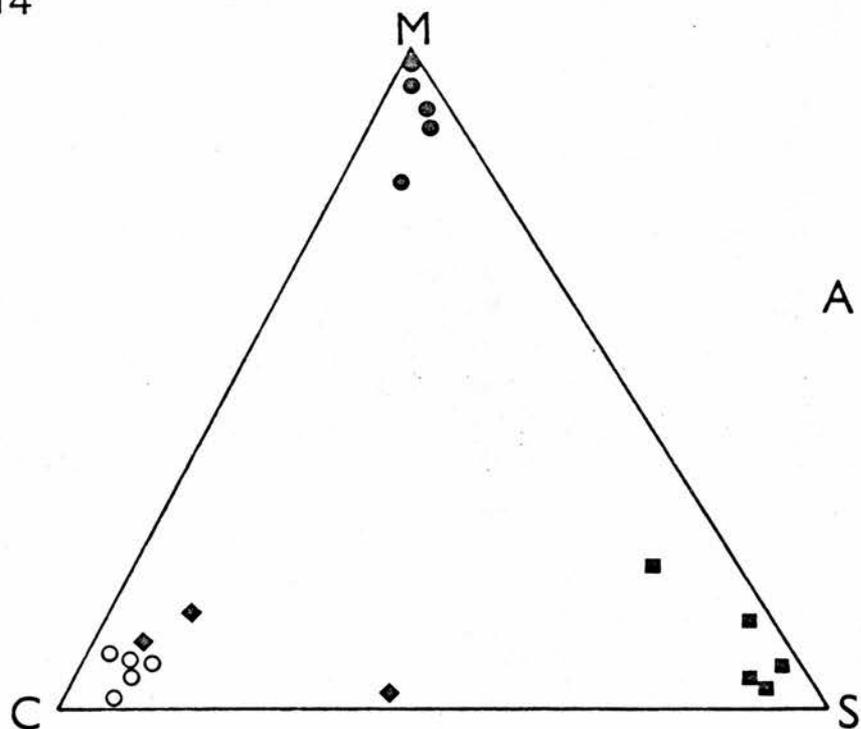
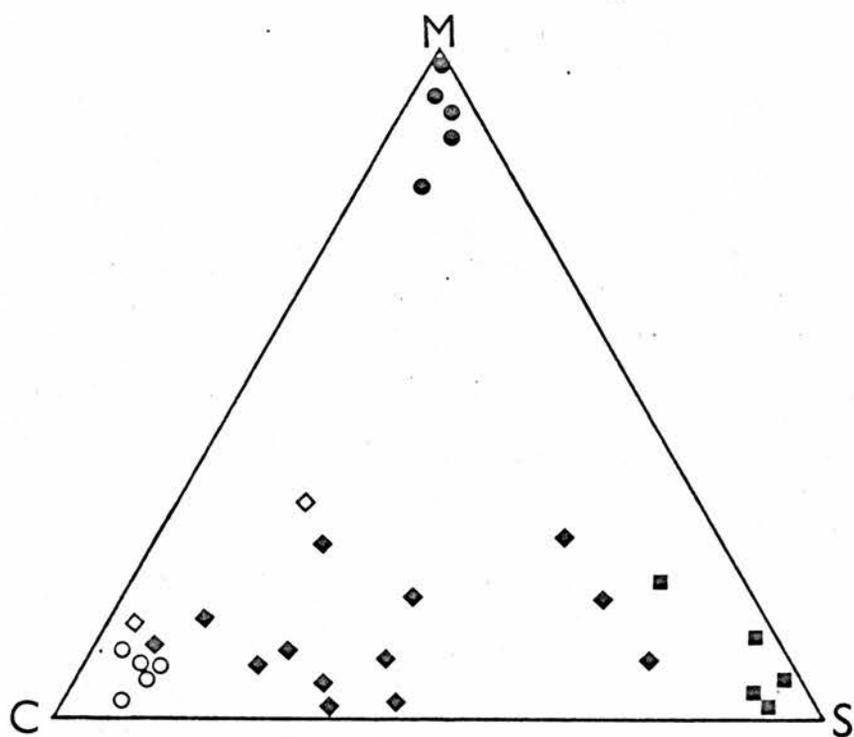


FIG. 15



Appendix (see Analysis of trihybrid populations, p. 95). The results were finally plotted on a triangular graph of which the three species were the apices. As before, T. spachiana falls between T. canariensis and T. stenopetala, which is particularly interesting here because although T. spachiana resembles T. monspessulana in overall size it nevertheless shows no affinity for this species. If T. spachiana is considered a hybrid species, it can be seen from the graph (fig. 14A) that specimens from Tenerife have a fairly high proportion of T. canariensis genome; in Europe (fig. 15C) cultivated material is generally of T. spachiana - stenopetala type (possibly accounted for by the fact that T. stenopetala and spachiana - stenopetala hybrids are reported to be more hardy than T. canariensis), whilst in California (fig. 14B) most specimens include T. monspessulana genome and in this case there are far more specimens of hybrids than of pure species.

Nomenclature of hybrid taxa

From cultivated specimens and descriptions in horticultural literature it appears that there is some confusion as to nomenclature in this group and that a number of names refer to slightly different hybrids.

The earliest name referring to a member of this group is Genista racemosa (authority unknown). Fischer (1837) transferred this species to the genus Cytisus and 'legitimised' it as Cytisus chryso botrys Fisch. The description given by Fischer is

of a plant with leaves 25-31 x 8-12 mm., pedicels 4 mm., corolla 12 mm. and inflorescence 75 mm. This description could refer either to pure T. stenopetala or to a hybrid between T. spachiana and a large-leaved specimen of T. stenopetala. C. racemosus Marnock (1837), with a somewhat vague description and illustration, could also refer either to T. stenopetala or to the hybrid with T. spachiana. Unfortunately some authors have taken G. spachiana Webb (1845) to be a synonym of C. racemosus Marnock and have described under this name a plant nearer T. stenopetala. Nicholson (1884) describes C. racemosus with leaves 6-18 mm. long and thus must be referring to T. spachiana (sensu Webb) rather than C. racemosus Marnock. C. everestianus (authority unknown), or C. racemosus var. everestianus, appears to be a segregate of T. spachiana towards T. canariensis since it is said to be somewhat dwarfer in form.

According to the Royal Horticultural Society Dictionary of Gardening, C. fragrans is a synonym for T. spachiana. However, plants labelled as C. fragrans in cultivation at St. Andrews, although they appear to contain mainly the spachiana genome, also have the short indeterminate inflorescence and retuse leaves of T. monspessulana. The cross T. spachiana x T. monspessulana (= C.x Porlock) was synthesised by Haddon in 1920 simply by cultivating the two species together: the offspring was reported to have leaflets 6-12 mm. in length, obovate or oblanceolate, usually with a rounded apex, often mucronulate, sometimes notched; flowers 6-12 mm. long in racemes or clusters, fragrant. This description

resembles many of the Californian specimens discussed above.

C. racemosus var. elegans, with larger flowers than C. racemosus (or T. spachiana), greayer leaves which are up to 50 mm. long, propagated by grafting since it does not breed true, is possibly a hybrid of T. spachiana with a large-leaved specimen of T. stenopetala var. stenopetala, which has arisen in cultivation.

3) T. spachiana and T. paivae

On the grounds of general morphology, it appears that T. paivae and T. maderensis are more closely allied to the species stenopetala - spachiana - canariensis than to the other members of the genus. While T. maderensis appears to combine some more extreme characters (eg., large leaves and flowers cf. T. stenopetala, with relatively large stipules, bracteoles and calyx cf. T. canariensis), T. paivae is more intermediate in character and thus superficially resembles T. spachiana. However, whereas T. spachiana is completely intermediate between T. stenopetala and T. canariensis, T. paivae is more like a smaller T. stenopetala, from which it can be distinguished by its size. It differs somewhat from T. spachiana in several characters (although these usually overlap in range) and in the shape of the calyx. T. paivae has a short calyx with minute lower lip teeth whereas T. spachiana has a long calyx with long, distinct lower lip teeth. Differences between the two taxa are illustrated by the scatter diagrams, fig. 16.

Fig. 16: Scatter diagrams demonstrating correlation
of characters in T. spachiana and T. paivae

■ T. spachiana □ T. paivae

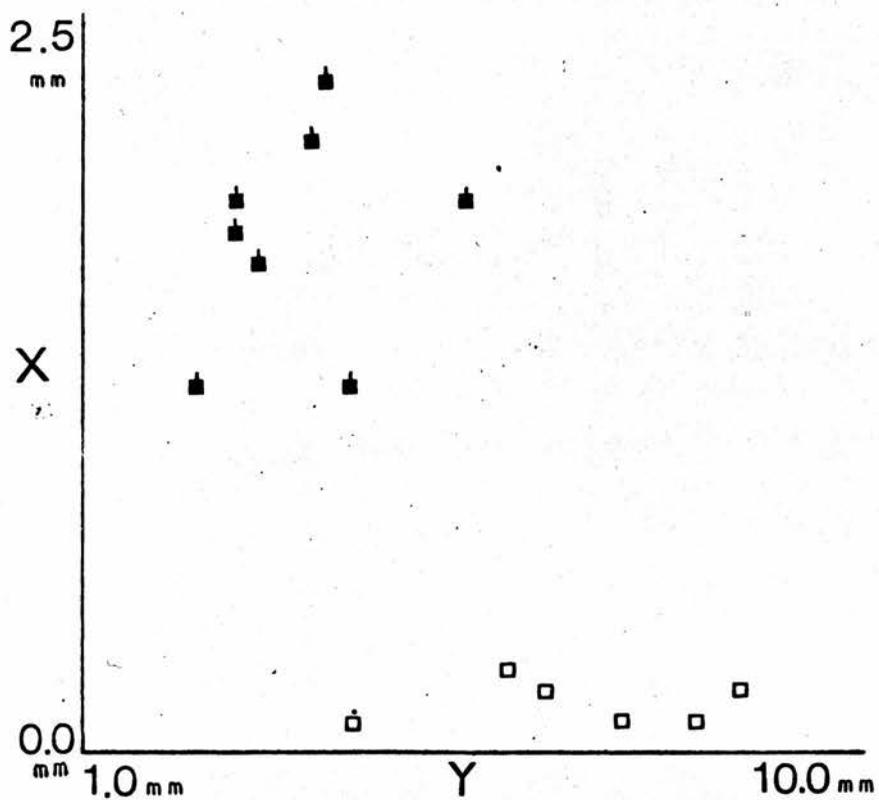
A: Calyx lower teeth length (X axis) and
petiole length (Y axis)

- Bracteole 1.1 mm. or more
- Bracteole 1.0 mm.
- Bracteole 0.9 mm. or less

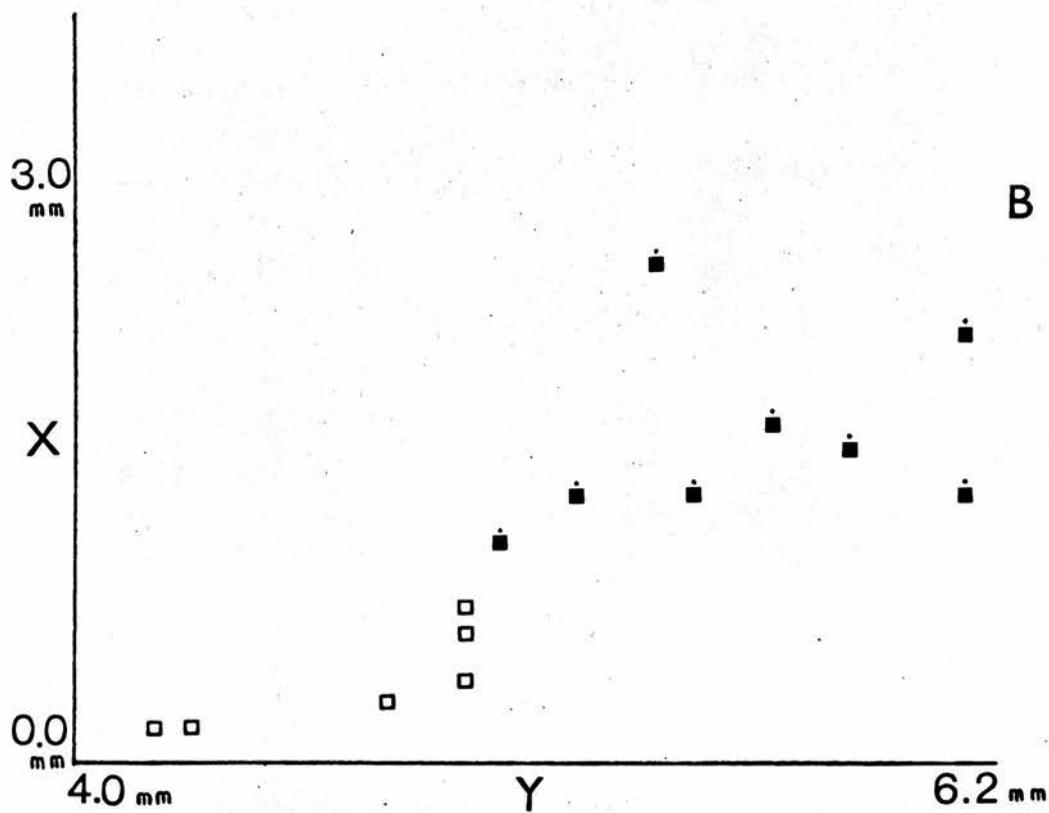
B: Bracteole length (X axis) and calyx length
(Y axis)

- No. of trifoliolate bracts 2 or more
- No. of trifoliolate bracts 0 or 1

FIG.16



A



B

SECTION III
COMPUTER STUDIES

COMPUTER STUDIES

In addition to normal taxonomic procedures, the results of morphological studies on the species were subjected to computer analysis. Various established computing techniques were applied with little success to this data, but one more recently formulated technique, Modal Analysis (Wishart, 1968), gave better results. Primarily the computing methods were used to investigate the hybrids formed between T. canariensis, T. spachiana, T. stenopetala and T. monspessulana. Subsequently the genus as a whole was also studied.

Although the results were in the main unsatisfactory, the investigation has afforded some insight into computing problems with regard to natural biological situations. Since most of the classifications suggested by the analyses are obviously unacceptable, it must be assumed either that the techniques were not suitable, or that the data was in some way not suitable for the techniques. In this context, it is unfortunate that binary characters had to be omitted since none of the methods was able to analyse mixed-mode data: the limitations set by analysis of data from a number of characters as opposed to the noting of innumerable details by the human eye must be kept in mind. Also, in the study of the genus as a whole, only those characters were employed which had been already used in the hybrid analysis : possibly more characters would have resulted in a more acceptable classification, but unfortunately specimens on loan had already

been sent back so that it was not possible to make more measurements.

It became apparent in the study of the four species T. canariensis, T. spachiana, T. stenopetala and T. monspessulana and their hybrids, that most techniques would give acceptable classifications if pure specimens, or specimens from natural localities only, were analysed. The addition of hybrids, or intermediates between groups, causes linkages which result in less significant classifications, particularly where the number of hybrids outnumber the total number of pure specimens. Modal Analysis was the only technique to produce meaningful results when both pure and hybrid specimens were analysed, presumably because this programme rejects single specimens linking larger clusters for the classificatory process.

1) T. canariensis, T. spachiana, T. stenopetala, T. monspessulana and hybrids

Data from specimens of the four species and hybrids were analysed with four computing methods. Nineteen parameters were used:

Leaflet length	No. of flowers per raceme
Leaflet length/width ratio	Pediceal length
Petiolule length	Floral interval
Petiole length	Corolla length
Leaflet/petiole length ratio	Standard petal indumentum
Stipule length	Floral interval/petiolule length ratio
Leaflet/stipule length ratio	Leaflet length/floral interval ratio
Bracteole length	No. flowers/petiole length ratio
Stipule/bracteole length ratio	Floral interval/stipule length ratio
Inflorescence length	

a) Modal Analysis

In most classificatory programmes, clustering is achieved by comparing the hyperspace distance from each individual to every other individual, with a critical threshold distance, and those individuals between which the distance is less than the critical threshold are linked and classified. Single-link individuals between large clusters can cause the latter to 'chain', the resulting classification therefore grouping clusters together although they may be only remotely related. Modal analysis differs from these programmes by adding to the usual critical threshold distance a critical threshold density criterion, which prevents chaining since only those individuals with a density higher than the critical density are used for the classification. The density of a point is defined as the number of other points falling inside a sphere (radius = critical threshold distance) around that point. Those points with a density of at least K (critical threshold density) are classified further by single-link clustering, i.e., using the critical distance criterion only. Points with a density of less than the critical threshold have no effect on the principal classification and are subsequently added to the clusters according to their nearest dense point. A list of K -linkage data, giving the distance of the closest 15-250 individuals in order is most useful, especially in this case, where hybrids were being compared with pure species. One disadvantage of this technique, however, is that the classification of a non-dense point depends on the single nearest dense point alone.

Where there are few specimens of a taxon, and none of them achieve dense status, this is likely to cause the grouping of such specimens with 'denser' taxa, i.e., those with a greater number of individuals. Another disadvantage is that both critical threshold distance and density are arbitrarily decided upon by the investigator. Since several clustering arrangements result from variation in threshold distance and/or density, some knowledge of the group is essential for the selection of the most significant classification.

In this case, the most significant groupings appear at 4 clusters, $K = 3$:

- cluster 1 T. canariensis, T. spachiana, Californian specimens.
- cluster 2 T. stenopetala, T. spachiana, Californian specimens.
- cluster 3 T. monspessulana, Californian specimens.
- cluster 4 T. spachiana, Californian specimens.

This is a 'natural' classification since T. spachiana, which is intermediate between T. canariensis and T. stenopetala, is not confused with T. monspessulana, which it resembles in overall size. On closer examination it appears that specimens of T. spachiana which are nearer T. canariensis or T. stenopetala in character are classified with these species respectively, while the more intermediate specimens are grouped separately. The appearance of Californian specimens also tallies with the groups in which they are placed, with a few exceptions. Useful information could also be drawn from the K-linkage data since included in the 15 or 30 closest specimens to a hybrid is usually

at least one specimen of the species which the hybrid most resembles in character. However, the second species involved in a di-hybrid did not usually occur in the first 30 specimens, possibly because so many hybrids were closer to other hybrids than to pure species specimens. Thus no conclusions as to actual percentage composition of specimens could be drawn. Better results might be obtained if fewer hybrid specimens were added to the pure species at a time for analysis, and the programme run several times. In this analysis, the total of suspected hybrid specimens amounted to 58 whereas the total of specimens for each species was: T. stenopetala, 14; T. canariensis, 18; T. monspessulana, 20. Thus hybrids outnumbered by far any pure species. If batches of 15 or 20 hybrids were added to the pure specimens at a time, not only would the parental species be shown up more clearly in the K-linkage data but also a clearer classification would probably ensue since pure specimens could not be so closely linked by hybrid specimens.

The following techniques were unsatisfactory:

b) Centroid

At the 5-cluster level, this technique combines T. monspessulana and T. canariensis in one cluster, so that it is of no use in determining the composition of hybrid specimens.

c) Furthest Neighbour

As in Centroid, T. canariensis and T. monspessulana fuse so that this classification is also unacceptable.

d) Group Average

Here, at the four-cluster level, T. canariensis, T. spachiana and T. monspessulana are combined into one large cluster.

2) Investigation of the genus as a whole

Various computing techniques were used on data from specimens of all the species of the genus, using the same parameters. The Californian specimens were at first not included.

a) Modal Analysis

Significant results were obtained with Modal Analysis at $2K = 3$, with seven clusters corresponding to seven species (ie., excluding T. spachiana, which was included in the T. canariensis cluster, presumably because there are intermediates between these two species, and T. osmariensis, of which there was only one specimen, consequently not a dense point). When only dense points are considered, the groups correspond exactly to the existing taxonomic species; however, when non-dense points are also included, some specimens appear to be misplaced. These non-dense specimens were in every case (except T. osmariensis) close to a number of similar specimens of which none were dense points, so that the nearest dense point was of another species. The following clusters were formed:

1) T. canariensis, T. spachiana, T. osmariensis (1 specimen), T. paivae (1 specimen).

2) T. stenopetala.

3) T. maderensis.

- 4) T. paivae, T. stenopetala (1 specimen).
- 5) T. monspessulana, T. paivae (1 specimen), T. linifolia subsp. linifolia - T. monspessulana hybrids (2 specimens), T. linifolia subsp. teneriffae (1 specimen).
- 6) T. microphylla.
- 7) T. linifolia subsp. linifolia, rosmarinifolia, teneriffae, gomeræ and pallida.

It was thought that the intermediates between some species might have a considerable effect on the clustering, particularly in the case of T. linifolia and T. monspessulana, where hybrids form a link between the two groups. These hybrids were therefore removed, but unfortunately some Californian specimens of T. stenopetala and T. monspessulana which appeared pure were included. The latter appear to have contained introgressed material of other species, since an odd clustering ensued which was not as meaningful as the first analysis clustering, eg., T. monspessulana and T. paivae were clustered together. It is possible that when the most obvious diagnostic (binary) character of indeterminate versus determinate inflorescence is removed, as it was in these analyses, T. monspessulana containing introgressed T. stenopetala or T. spachiana resembles T. paivae closely in other characters. At all clustering levels the classification appeared less satisfactory than in the previous analysis.

In a third analysis, all the Californian specimens were added, but this, instead of pin-pointing the species involved in the hybrids, resulted in a meaningless classification with

hybrids (which obviously involve only three species) occurring in almost every cluster.

b) Furthest Neighbour

On data from all species as well as the seemingly pure Californian specimens, Furthest Neighbour gave poor results, eg., at 8-cluster level, T. canariensis, T. microphylla and T. linifolia subsp. rosmarinifolia were included in one group, T. paivae and T. monspessulana constituted another, while four groups were devoted to the remaining T. linifolia subspecies and two to T. stenopetala.

c) Group Average

Even at the 11-cluster level, this technique produced one large group combining T. canariensis, T. paivae, T. monspessulana and T. microphylla, and 10 other very small clusters.

d) Centroid

Once again an unacceptable classification was produced: at 8 clusters, T. canariensis, T. paivae, T. monspessulana and T. microphylla combined into one group, T. stenopetala, T. maderensis and a few T. paivae specimens forming another, and 6 other very small groups.

c) Ward's Method

This technique gave somewhat better results, and at 9 clusters fairly good groups were produced: T. paivae, T. monspessulana, T. stenopetala and T. maderensis were recognised as separate groups, T. linifolia subspecies fell into two clusters,

while T. canariensis, T. microphylla and T. spachiana formed the only composite group. The latter is acceptable because there are intermediates between T. canariensis and each of the other species.

f) Flexible

This analysis produced somewhat similar results but here T. paivae and T. nonspessulana were once again grouped together at the 9-cluster level. At 7 clusters, T. madreensis was added to the T. paivae - T. nonspessulana cluster although there were still 2 clusters of T. stenopetala specimens.

The detailed print-outs of these analyses are obtainable from Dr P.E. Gibbs at the Department of Botany, University of St. Andrews.

SECTION IV

TAXONOMIC TREATMENT

TELINE MedikusVorles. Churpf. 2:342 (1787)Syn. Genista subg. Teline Spach, Ann. Sc. Nat. Bot., ser. 3, 3:150
(1845).Cytisus sect. Teline Bentham, Gen. Pl.:484 (1862)

Shrubs or small trees, non-spiny, with alternate branching. Leaves alternate (often nearly opposite), trifoliolate, usually petiolate; stipules usually present. Flowers borne alternately, sometimes opposite, in racemes or heads. Calyx tubular at the base, with prominent upper and lower lips, the upper deeply bifid, the lower lip with three distinct to indistinct teeth. Standard narrowly to broadly ovate, emarginate or entire at the apex, glabrous or sericeo-pubescent, as long as or slightly shorter than the keel. Wings glabrous, as long as the keel. Keel oblong, sericeous to pubescent. Legume narrowly oblong, compressed, 2-8 seeded, sericeous, pubescent or hirsute. Seeds strophiolate, grey-green, dark brown or black.

Type species: T. monspessulana (L.) Koch.Key to the species of Teline

- A. Bracteoles broadly ovate (4.5 mm. long), caducous; standard petal markedly lobed at the base (9) osmariensis
- A'. Bracteoles linear to elliptic, or if ovate, less than 3 mm. long, persistent; standard petal not lobed
- B. Standard petal usually uniformly sericeous (sericeous area

never V-shaped); leaves sessile or subsessile, or if shortly petiolate, then petiole less than 1/7th the length of the leaflet (8) linifolia

B'. Standard petal glabrous or nearly so, or with a V-shaped sericeous area at the apex; leaves petiolate, petiole always more than 1/7th the length of the leaflet

C. Stipules 4.0-6.0 mm.; leaflet mucro 0.4-0.6 mm.¹
(6) maderensis

C'. Stipules 0.5-2.5 mm.; leaflet mucro 0.0-0.3 mm.

D. Inflorescence indeterminate; legume hirsute-lanate
(7) monspessulana

D'. Inflorescence determinate; legume shortly tomentose to sericeous

E. Standard glabrous (rarely with a slightly puberulent midvein); bracteoles 0.4-1.0 mm. long; calyx lower teeth usually indistinct

F. Corolla 12.5-15.5 mm. long; leaflets 19-45 mm. long, apex acute
(2) stenopetala

F'. Corolla 9.0-12.5 mm. long; leaflets 8-16 mm. long, apex obtuse or retuse
(5) paivae

E'. Standard pubescent (with a distinct line of hairs from the apex, or V-shaped sericeous area); bracteoles 1.0-3.0 mm. long; calyx teeth distinct

G. Leaves strongly involute (appearing linear-oblong); petiolule 0.0-0.2 mm. long; twigs, leaves, and calyx with short, dense, woolly-tomentose indumentum
(4) microphylla

G'. Leaves not, or only slightly, involute (never appearing linear-oblong); petiolule 0.3-0.8 mm. long; twigs, leaves and calyx sericeous-villous

H. Leaflets 2.5-6.0 mm. long; petioles 1.0-3.0 mm. long
(1) canariensis

H'. Leaflets 5-12 mm. long; petioles 2.5-6.0 mm. long
(3) spachiana

¹Throughout this investigation average, rather than absolute, lengths of mature organs have been used.

1. T. canariensis (L.) Webb & Berthelot, Phyt. Canar. 3(2):37 (1842).

Syn. Genista canariensis L., Sp. Pl., ed 1, 2:709 (1753).

Cytisus candicans β Lam., Encycl. Méth. Bot. 2:248 (1786).

Spartium albicans Cav., Anal. Cienc. Nat , 4:64 (1801).

Cytisus paniculatus Lois., Nouv. Duham.:148 (1810).

Cytisus ramosissimus Poir., in Lam., Encycl. Méth. Bot ,
Suppl. 2:440 (1812).

Teline ramosissima ^(Poir.) W. & B., loc. cit.:38 (1842).

Genista hillebrandtii Christ, in Engl., Bot. Jahrb. 4:121 (1886).

Cytisus canariensis ^(L.) O. Kuntze, Rev. Gen. Pl., 1:177 (1891).
^ (non C. canariensis Poir., Encycl. Suppl.
2:440 (1812) = Adenocarpus viscosus)

Cytisus hillebrandtii (Christ) Briq., Etud. sur les Cyt.
des Alp. Marit.:137 (1894).

Erect or spreading much-branched shrub, up to 3 m.; branches
± congested, softly patent-pubescent, sometimes ferruginous; internodes
short. Leaves trifoliolate, petioles 1-3 mm.; leaflets 3-6 x 1.5-3.2
mm., obovate to subrotund, slightly involute, apex obtuse to acute,
apiculate or mucronulate; leaflets subglabrous to sparsely pubescent
above, densely so below; petiolule 0.2-0.5 mm.; stipules 0.5-1.3 mm.,
acuminate. Inflorescence 10-50 mm., determinate, a raceme of 4-15
flowers. Bracts subtending the lowermost 3-10, or rarely all, flowers,
sub-foliaceous, trifoliolate, those of the upper flowers much reduced,
simple; pedicels 1.0-2.5 mm.; bracteoles (2) 1.5-3.0 mm., elliptic to
narrowly ovate, borne at the base of the calyx. Calyx 4-6 mm., densely
sericeo-pubescent, upper teeth cuspidate, lower teeth long, ± linear,

distinct. Standard 10-11.5 mm., broadly ovate, emarginate, sericeous or sericeo-pubescent in a characteristically V-shaped area. Keel + uniformly sericeous. Legume 15-25 x 3-5 mm., narrowly oblong, densely silky-woolly with a short indumentum. Fl. January - July.

Ecology: dry hillsides, margins of woodland, 500-1500 msm.

Distribution: Canary Islands. Tenerife, Gran Canaria (see map 4).

Type: Hort. Cliff. no. 355 (BM) n.v.

also no. 892.1 (Savage Catalogue 1945) in the Linnaean herbarium (LINN).

Icon: fig. 17; also Webb & Berthelot, loc. cit. t. 41.

ISLAS CANARIAS

TENERIFE: Tacoronte, Cerro de Guerra, 700 msm., 17. III. 1933, Asplund 367 (K); Tegueste, 12. I. 1845, Bourgeau 13 (K,E,LIVU); San Diego del Monte, V. 1846, Bourgeau 573 (K); Santa Cruz de Tenerife, Broussonet (MA 60722); Anaga Hills, 700-1000 msm., V. 1923, Burchard 159 (E); above La Perdoma, 500 msm., VIII. 1921, Burchard 31 (E); Monte de 'Aquirre', 21. VIII. 1945, Ceballos & Ortuno (MA); Realejo Alto, 6. II. 1935, Chaytor (K); Las Mercedes, 25. II. 1921, Grass & Borgesen 568 (K); Taganana, 1. V. 1891, Hamilton (E); Las Mercedes, 1. III. 1891, Hamilton (E); Santa Cruz de Mercedes, Alguna Peninsula, 10. IX. 1963, Hurst (LIVU); La Laguna, 23. III. 1888, Kuntze (K); Tigayga, above Realejo on road to Icod el Alto, 1. I. 1858, Lowe 146 (K); San Diego del Monte, Lowe (K); Barranco de Montijo, 4000', 1963, Mann N215 (K); Barranco near Villa Orotava, 1400', 9. VI. 1890, Murray (K);

San Diego del Monte, 6. II. 1899, Murray (E); Couverto de San Diego del Monte, 22. VI. 1892, Murray (E); between Laguna and Las Mercedes, 15. IV. 1902, Murray (K); Anaga Hills, 19. V. 1890, Murray (K); Las Mercedes, 22. III. 1930, Nielsen 1684 (K); Orotava, 19. IV. 1913, Perez (K); Barranco de la Rutana de Chanas, Puerto Orotava, 14. VI. 1912, Perez (K); Las Mercedes, 900 msm., IV. 1906, Pitard (H); Bajamar, Sobrado (MA 60725); San Diego, 30. VI. 1905, Sobrado & Vicioso (MA); Las Mercedes, I. 1925, Spooner (K); Las Mercedes, 18. VI. 1913, Sprague & Hutchinson 612 (K); Las Mercedes, Webb (K); without precise locality: 'in sylvaticis montanae mediae', IV-V. 1855, Bourgeau 1300 (MANCH, K), 1301 (MANCH, K), 1302 (MANCH, K, E); Broussonet (MA 60721); II. 1955, Proby (K), and 11. II. 1955, Proby 38 (K); 'in collibus apricis', Webb (K, MANCH).

GRAN CANARIA: Moya, convalle supra Los Tilos, 3. III. 1933, Asplund (K); Barranco de la Virgen, III. 1846, Bourgeau 397 (E,K).
Cultivated specimens: Tenerife, Orotava, 15. IV. 1913, Perez (K); France, 2. IX. 1843, Webb (K); without collector, as 'C. attleanus', IV. 1899 (K); ex horto bot. Petropolitano, as 'Genista canariensis', V. 1882 (K).

Anomalous specimens, Gran Canaria: near Guia, 19. VI. 1892, Murray (K); Santa Brigida, 19. III. 1933, Trethewy 157 (K).

Obs. Webb & Berthelot (1842) distinguished a second species from Tenerife as T. ramosissima, although subsequent authors, eg. Briquet (1894) and Pitard & Proust (1909) have treated this taxon as a variant

of T. canariensis. According to Webb & Berthelot (loc. cit.) the two taxa occupy different ecological habitats, viz. T. canariensis: 'In collibus apricis sub montibus lauriferis insulae Teneriffae, inter zonam sylvosum et maritimam' and for T. ramosissima, 'In dumetis ad margines sylvarum in insula Teneriffa, specimina nostra a sylva de Las Mercedes seu episcopi, et ab Aquae Monte proveniunt.'

Exsiccatae referable to T. canariensis - ramosissima which have been seen include both a duplicate of the Broussonet specimen from Santa Cruz cited by the authors (loc. cit.) and specimens collected by Webb 'in collibus apricis' for canariensis and several collections including a Webb specimen from Las Mercedes, the type locality for ramosissima. Detailed studies on this material have not shown any character correlations which would allow these specimens to be divided into two taxa of even varietal rank. Further, the differential characters cited for these taxa, eg. diffuse as opposed to congested branching and racemes, degree of hairiness, etc. suggest that T. canariensis - ramosissima differences may be due to phenotypic variation in response to different habitats. Consequently, T. ramosissima has been treated as a synonym of T. canariensis in the present account.

Christ (1888) described the species Genista hillebrandtii from Gran Canaria, but did not cite a holotype specimen or type locality. Subsequently, De Wildeman (1905) cited 'Hillebrandt and Askenazy, Montana de Galdar, Gran Canaria', a specimen which has not been seen, for this taxon.

However, the description of G. hillebrandtii by Christ and also the illustration for this species by De Wildeman resemble T. canariensis. According to Christ, the species differs from T. canariensis by its longer leaflets and petioles, but in fact the range for G. hillebrandtii for these characters falls within the range for T. canariensis, albeit at the upper limit. A specimen has been seen from Moya, near Galdar, (Asplund, K) which resembles completely the description for G. hillebrandtii given by Christ. Genista hillebrandtii has therefore been treated as a synonym of T. canariensis.

Two specimens (Trethewy 157, from Santa Brigida, and Murray, from Guia) have been seen which are also within the G. hillebrandtii petiole and leaflet length range, ie. the upper limit of T. canariensis; however these resemble T. microphylla rather than the illustration given by De Wildeman, and it is possible that these have resulted from introgression of the T. microphylla genome into T. canariensis (see further discussion on p. 23).

T. canariensis and T. spachiana tend to grade into each other in Tenerife, and can only be distinguished by the larger overall size of T. spachiana. The status of T. spachiana is considered more fully under that species (p. 59).

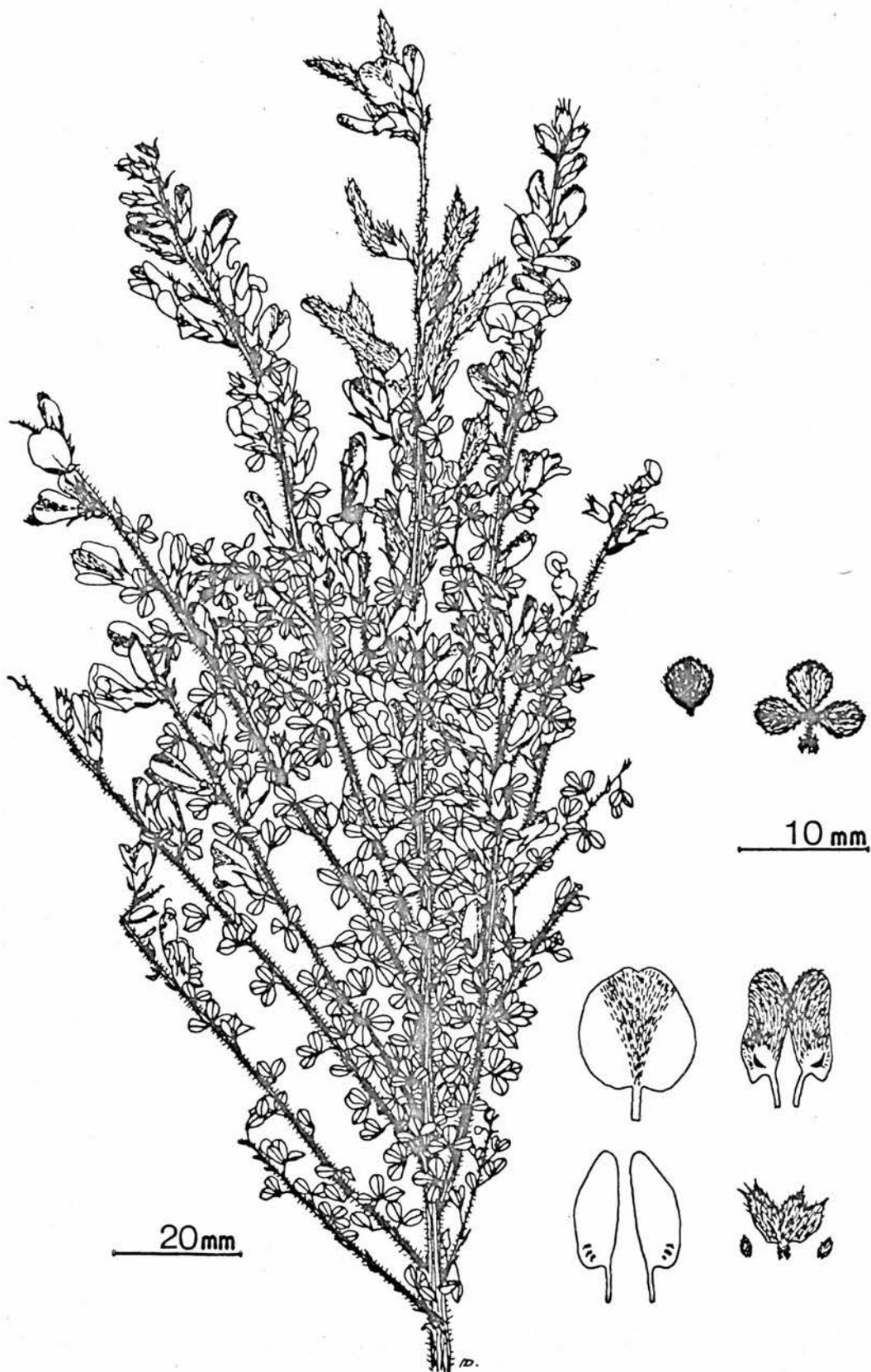
Two specimens from Agua Mansa in Tenerife have been seen (Bornmüller 458, LD; Hamilton, E) which do not correspond closely to either T. canariensis or T. spachiana. The dense villous indumentum, rather large leaves with relatively short petioles and short indeterminate inflor-

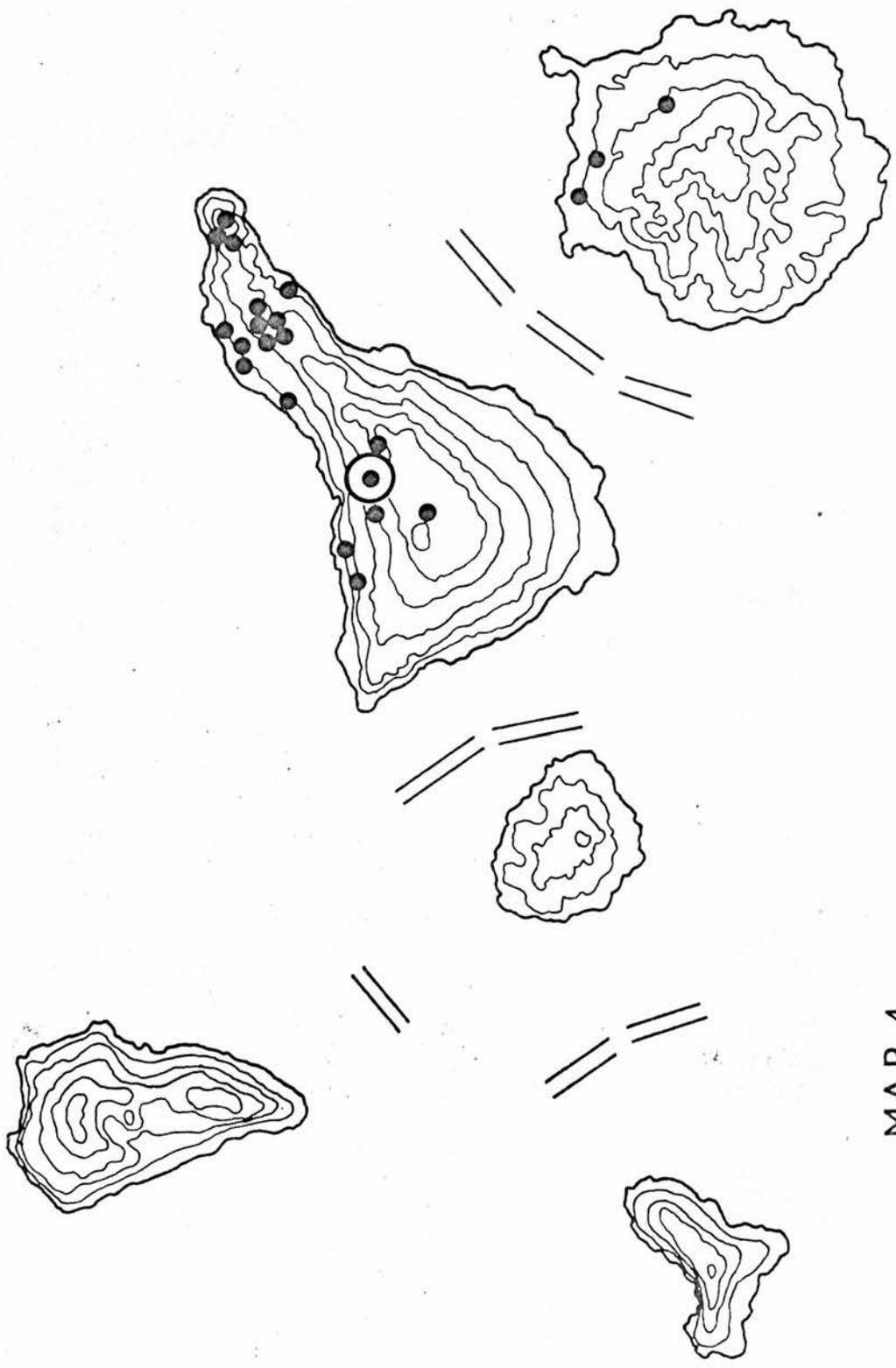
escences of these specimens suggest affinities with T. monspessulana, and they are considered in detail under that species (p. 76).

Fig. 17 (overleaf): T. canariensis (source material: for illustration, Tenerife, 'in collibus apricis', Webb, K; for corolla dissection, Tenerife, Santa Cruz, Broussonet, MA 60722)

Map 4: Distribution of T. canariensis

FIG.17





MAP 4

2. T. stenopetala (W. & B.) W. & B. Phyt. Canar. 3(2):39 (1842).

Syn. Genista stenopetala W. & B., loc. cit. t. 45 (1836).

? Cytisus chrysobotrys Fisch., in Otto & Dietr., Allg. Gart. Zeitg., 5:122 (1837).

^(W.&B.)
Cytisus stenopetalus Christ, in Engl., Bot. Jahrb., 9:162 (1887).

Cytisus maderensis var magnifoliosus (Kuntze) Briq., Etud. sur les Cyt. des Alp. Marit.:138 (1894).

C. maderensis var genuinus Briq., loc. cit., pro parte.

Shrub or small tree, up to 6 m.; branches sub-glabrous, twigs adpressed sericeous. Leaves trifoliolate, petioles 10-21 mm.; leaflets 19-45 x 5-18 mm., narrowly elliptic to oblanceolate, apex acute, macronulate; leaflets glabrous or sparsely to densely sericeous above, densely sericeous below; petiolule 0.5-1.5 mm.; stipules 1.0-2.5 mm., triangular. Inflorescence 35-130 mm., determinate, flowers 10-26 in an elongate raceme. Bract subtending the lowermost flower sometimes sub-foliaceous, trifoliolate, usually much reduced, simple, as are those of the upper flowers; pedicels 2.5-4 mm.; bracteoles (2) 0.4-1 mm., linear, borne at the base of the calyx. Calyx 4.5-7.0 mm., adpressed sericeous, the upper teeth acute, the lower teeth minute and usually indistinct. Standard 12-16 mm., broadly ovate, emarginate, glabrous, rarely puberulent along the midvein. Keel sericeous, particularly at the apex, becoming glabrous near the claw. Legume 20-35 x 3-7 mm., narrowly oblong, densely adpressed-sericeous. Fl. March - June.

Ecology: margins of woodland, barrancos. 600-800 msm.

Distribution: Canary Islands. La Palma, Hierro and Tenerife (recently

introduced in the latter island?). T. stenopetala has also been reported from the Cape Verde Islands, by Masferrer (1881) and Briquet (1894) but no specimens have been seen from natural localities outside the Canary Islands (map 5).

Type: Convalle del Rio, La Palma, Webb (MANCH, K).

Two varieties are recognised:

var (i) stenopetala

Syn. Cytisus stenopetalus var sericea, Pit. & Proust, Les Iles Canar. :152 (1909).

Cytisus stenopetalus var palmensis Pit. & Proust, loc. cit.

Cytisus stenopetalus var magnifoliosus Kuntze, Rev. Gen. Pl.:178 (1891).

Upper surface of leaf sparsely to densely sericeous.

Icon: Webb and Berthelot, loc. cit.t. 45 (1836).

ISLAS CANARIAS

LA PALMA: supra Santa Cruz, 600 msm., VI. 1922, Burchard 137 (E); Monte Enrique, 23. IV. 1946, Ceballos & Ortuno (MA 60727); between Garafia and Barlovento, 22. II. 1888, Kuntze (K); El Monte de Barlovento, 26. V. 1858, Lowe 342 (K); Barranco de las Asturias, Pitard 518 (BM); Convalle del Rio, Webb (MANCH, K).

HIERRO: 'In praeruptis del Golfo', 27. V. 1855, Bourgeau 1315 (MANCH).

TENERIFE: Valle de Orotava, Barranco San Antonio, 800 msm., 9. III. 1933, Asplund 17i (K); Tacoronte, 1932, Maude (BM).

Cultivated at the Jardim d'Acclimatacion, Orotava, Puerto de la

Cruz, Tenerife: seed in heather earth brought from near Agua Mansa, 26. V. 1913, Sprague & Hutchinson 32 (K); without collector but probably Perez (K).

var (ii) microphylla Pit. & Proust, Les Iles Canar.:151 (1909).

Upper surface of leaf glabrous

Icon: fig. 18.

ISLAS CANARIAS

HIERRO: Mocanal, 600 msm., 21. V. 1901, Bornmüller 2186 (BM, LD); Monte de Savinosa, VI. 1845, Bourgeau 90 (BM, MANCH, K); 'in praeruptis del Golfo', 27. V. 1855, Bourgeau 1315 (MA, K); Valverde, 650 msm., V. 1924, Burchard 286 (E); Vueltas, El Golfo, 18. II. 1850, Lowe H202 (BM, K); Vueltas de Xinamar, 10. V. 1899, Murray (K); Riscos de Xinamar, 800 msm., III. 1906, Pitard 517 (LD).

Cultivated at the Jardim d'Acclimatacion, Orotava, Puerto de la Cruz, Tenerife: 15. IV. 1913, Perez (K); 1913, Sprague & Hutchinson, 26 & 31 (K).

Other cultivated material: Hierro, Valverde, V. 1899, Murray (K); Britain, Tregotham, Truro, 15. V. 1915, Andrews & Watson (K).

Obs. It appears that var. stenopetala is largely confined to La Palma and Tenerife, while var. microphylla occurs only on Hierro; however, one specimen of var. stenopetala from Hierro has been seen (Bourgeau 1315) so that the distribution of these varieties is not clear-cut. The presence or absence of sericeous hairs on the upper surface of the leaf is reinforced to some extent by leaf size: var.

stenopetala has leaves 22-45 mm. long, var. microphylla 15-27 mm. Kuntze (1891) recognised large-leaved forms from La Palma as var. magnifoliosus, and it might appear, therefore, that var. magnifoliosus Kuntze corresponds to var. stenopetala as recognised above. However, Kuntze stated that var. magnifoliosus has leaves larger than those of specimens at Kew, which include material of var. stenopetala from La Palma; thus it appears that Kuntze attempted to distinguish specimens with large leaves on La Palma from other stenopetala on that island and therefore var. stenopetala and var. magnifoliosus Kuntze are not completely synonymous.

Lowe (1868) referred T. stenopetala to Genista maderensis (ie. T. maderensis W. & B.) and Briquet (1894) subsequently followed this treatment when he recognised Teline as a section in the genus Cytisus. However, Briquet appears to have misinterpreted var. magnifoliosus Kuntze since he described Cytisus maderensis with the varieties: var. rupicolus from Madeira; var. genuinus from Madeira and the Canary Islands; and var. magnifoliosus (syn. C. stenopetalus var. magnifoliosus Kuntze) distributed in the Canary Islands, Cape Verde Islands¹ and Madeira.

T. maderensis is a completely distinct species which is restricted to Madeira. It must be assumed, therefore, that var. rupicolus Briq. and specimens of var. genuinus Briq. from Madeira correspond to T. maderensis W. & B., whilst specimens of var. genuinus and var. magnifoliosus Briq. from the Canary Islands, are T. stenopetala W. & B.

¹ No specimens of T. stenopetala or T. maderensis have been seen from the Cape Verde Islands.

Specimens of the latter varieties cited by Briquet from Madeira must presumably be referred to T. maderensis since T. stenopetala is not known from Madeira. It should be noted that T. maderensis is readily distinguished from T. stenopetala by its long spreading ferruginous indumentum and larger stipules, bracteoles and calyx.

Pitard & Proust (1909) recognised four varieties of C. stenopetalus: var. palmensis and var. sericea (La Palma), var. microphylla (Hierro) and var. gomeræ (Gomera). Var. gomeræ resembles T. spachiana and has been referred to that species (see p. 58). Var. sericea and var. palmensis, with leaf upper surface sericeous and nearly glabrous respectively correspond to var. stenopetala (sensu G. & D.), while var. microphylla Pit. & Proust, with leaf upper surface glabrous, corresponds to var. microphylla in this account. The varying infra-specific classifications of T. stenopetala are tabulated on the next page.

Webb & Berthelot (1842) and Pitard & Proust (1909) cite specimens of T. stenopetala from La Palma and Hierro, but not from Tenerife, although both pairs of authors definitely collected on this island. Two specimens have been seen from Tenerife, both var. stenopetala (Barranco San Antonio, 1933, Asplund 171; Tacoronte, 1932, Maude) and according to García Cabezon (in litt. 1968) T. stenopetala occurs on the island. Since no specimens collected before 1930 have been seen from Tenerife, it is possible that the species has spread from the garden at Orotava, subsequent to the floristic studies by Pitard

& Proust (1909). This view is supported by the proximity of San Antonio to Orotava and of Tacoronte to San Antonio, and by the similarity of the wild plants to actual cultivated material at Orotava.

Infraspecific classifications of *T. stenopetala*

Taxon & Author	Distribution	Leaf length	Leaf upper surface	Raceme length (mm.)	Taxon in this investigation
Webb (1842) <u><i>T. stenopetala</i></u>	La Palma	(22-45	sericeous	variable) ¹	var. <u><i>stenopetala</i></u>
Kuntze (1891) <u><i>C. stenopetalus</i></u> v. <u><i>magnifoliosus</i></u>	La Palma	'large'	-	-	(<u>sensu G.&D.</u>) La Palma, Hierro, (Tenerife).
Briquet (1894) <u><i>C. maderensis</i></u> v. <u><i>magnifoliosus</i></u>	Canary Is., Madeira, Cape Verde Is.	30-35	-	elongate	Leaf length 22-45 mm.; leaf upper surface sparsely to densely sericeous; raceme length variable.
Pitard & Proust (1909) <u><i>C. stenopetalus</i></u> v. <u><i>sericea</i></u>	La Palma	25	densely adpressed sericeous	30-60	
Pitard & Proust (1909) <u><i>C. stenopetalus</i></u> v. <u><i>palmensis</i></u>	La Palma	25	nearly glabrous	50-150	
Kuntze (1891) <u><i>C. stenopetalus</i></u> (v. <u><i>stenopetalus</i></u>)	? La Palma & Hierro	'not so large'	-	-	var. <u><i>microphylla</i></u> (<u>sensu G.&D.</u>) Hierro.
Pitard & Proust (1909) <u><i>C. stenopetalus</i></u> v. <u><i>microphylla</i></u>	Hierro	18	glabrous or sub- glabrous	50- 100	Leaf length 15-27 mm.; leaf upper surface glabrous; raceme length variable.
Briquet <u><i>C. maderensis</i></u> v. <u><i>genuinus</i></u> excl. <u><i>T. maderensis</i></u> W. & B.	Canary Islands	10-20	-	elongate	length variable.

¹ measured from authenticated Webb specimens.

Fig. 18: T. stenopetala var. microphylla

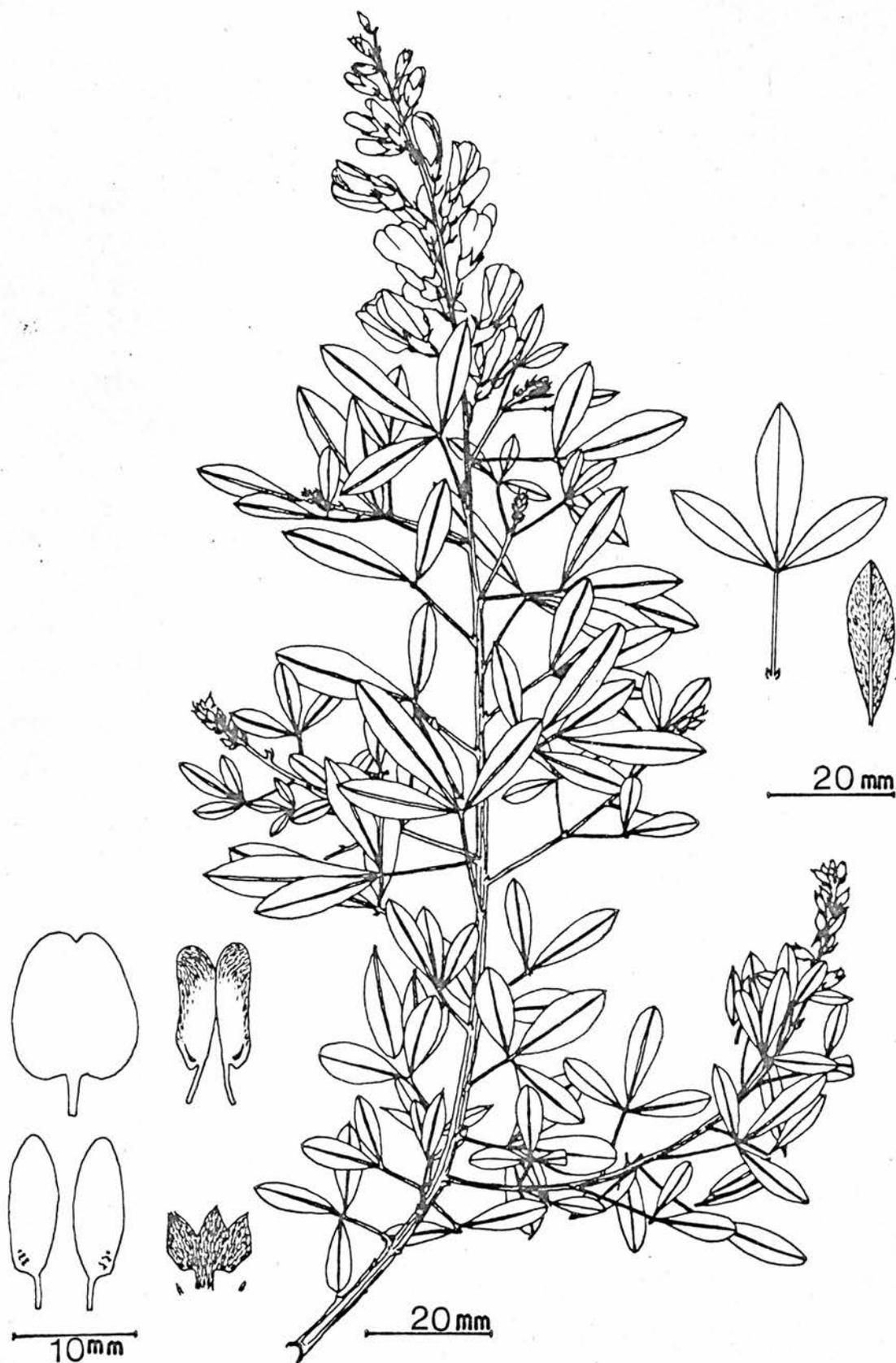
(source material: for illustration, Hierro, Vueltas, El Golfo, 18. II. 1850, Lowe H202, K; for corolla dissection: Hierro, Mocanal, 21. V. 1901, Bornmüller 2186, LD)

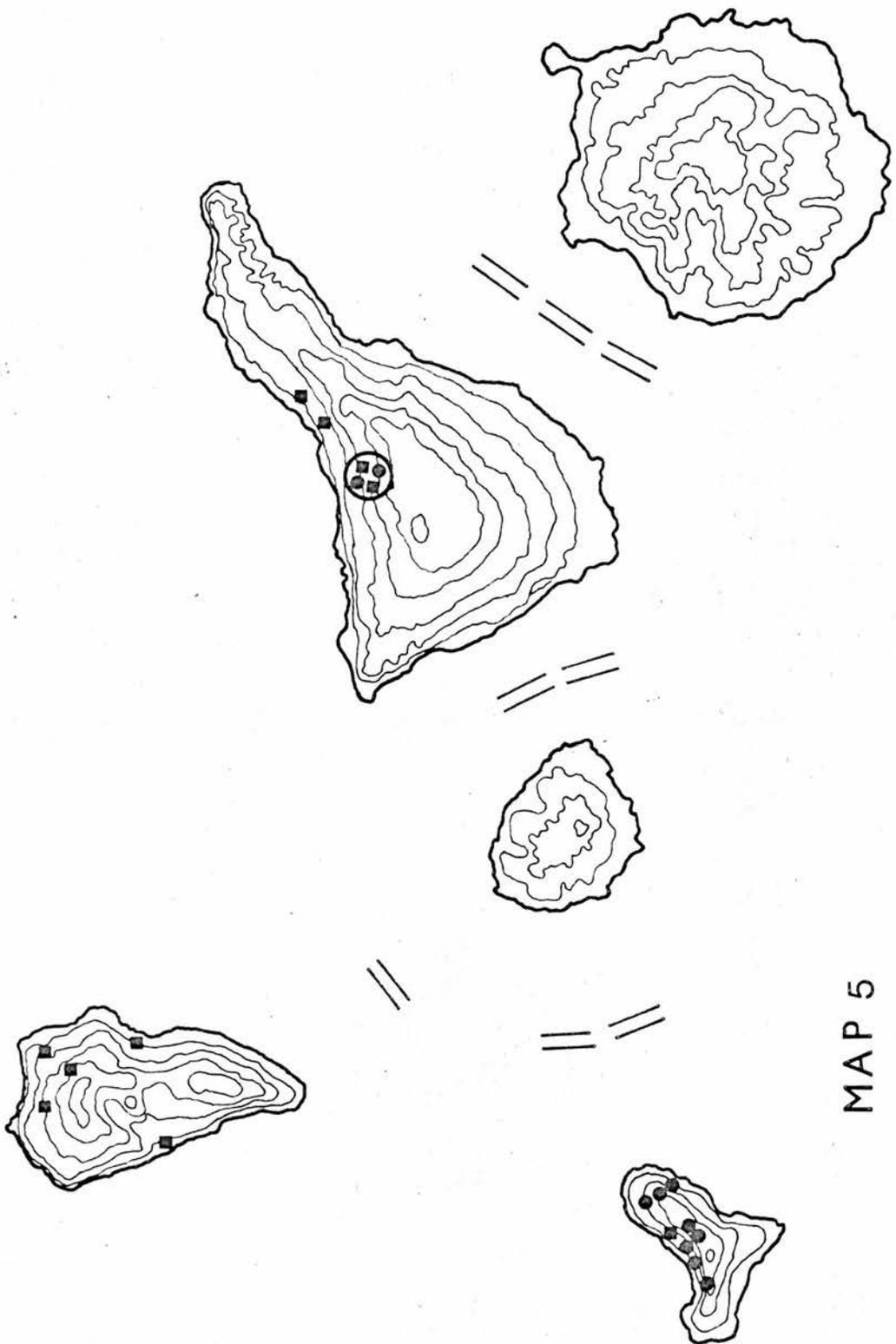
Map 5 (overleaf): Distribution of T. stenopetala

■ var. stenopetala

● var. microphylla

FIG. 18





MAP 5

3. T. spachiana (Webb) G. & D., comb. nov. ined.

Syn. Genista spachiana Webb, Bot. Mag. 71: tab. 4195 (1845).

Cytisus racemosus Nicholson, Dict. Gard. 1:430 (1884).

Cytisus fragrans Auct., non Lam.

Cytisus stenopetalus var. gomeræ, Pit. & Proust, Les Iles Canar.: (1909).

Erect, branching shrub up to 3m.; branches sub-glabrous, twigs \pm densely sericeous, hairs adpressed to spreading. Leaves trifoliolate, petioles 2.5-6.0 mm.; leaflets 5-12 x 2.5-4.5 mm., oblanceolate to narrowly obovate, apex obtuse, mucronulate; leaflets glabrate to adpressed-sericeous above, \pm densely so beneath; petiolule 0.4-0.6 mm.; stipules 1-2 mm., acute. Inflorescence 35-120 mm., determinate, a raceme of 9-30 flowers. Bracts subtending the lowermost (1-4) flowers sub-foliaceous, trifoliolate, those of the upper flowers much reduced, simple; pedicels 2-4 mm.; bracteoles (2) 1-2.5 mm., linear or elliptic, borne at the base of the calyx. Calyx 5-6.5 mm., sericeous, hairs spreading to adpressed; upper teeth cuspidate, lower teeth moderately long, distinct. Standard 11-14 mm., broadly ovate, emarginate, glabrous apart from a \pm broad V-shaped, finely adpressed-sericeous area at the apex. Keel shortly adpressed-sericeous, becoming glabrous near the claw. Legume 12-24 x 2-5 mm., narrowly oblong, densely sericeo-pubescent to adpressed-sericeous. Fl. April - May.

Ecology: margins of woodland.

Distribution: Canary Isles. Tenerife and Gomera (map 6).

Type: not traced (probably the specimen from which tab. 4195 was drawn to accompany the description of the species by Webb, in Bot. Mag. 71, 1845).

Icon: fig. 19; also Webb (loc. cit.).

ISLAS CANARIAS

TENERIFE: Agua Garcia, 800 msm., IV. 1920, Burchard 39 (E).

GOMERA: El Monte Hermigua, 17. IV. 1861, Lowe 117G (K, BM).

Specimens cultivated at the Jardim d'Acclimatacion, Orotava:

seed from La Mortola, 18. IV. 1913, Perez (K); seed from Agua Garcia, 18. IV. 1913, Perez (K); 26. V. 1913, Sprague & Hutchinson 96 (K); seed from Barranco Gracia (or del Drago), near Laguna, 18. IV. 1913, Perez (K); 26. V. 1913, Sprague and Hutchinson 33 (K); seed in heather earth brought from mountains above Orotava, 9. III. 1912 and 15. IV. 1913, Perez (K); without precise locality, 18. IV. 1913, Perez (K); IV. 1905, Buchthery (E).

Other cultivated material: France, Jaroins, V. 1927, Sennen and Secondeire (LD); Germany, Breslau, Königl. Bot. Gard., 2. VIII. 1909, Baenitz (E); Britain, Fishbourne, Isle of Wight, 2. V. 1961, White (K); without locality: Gamble 28899 (K); without collector: as 'Cytisus everestianus', V. 1822 (K); Chelsea, as 'Genista bracteolata', IV. 1851 (K); Hort. Kew., as 'Cytisus racemosus', V. 1882 (K).

Obs. T. spachiana is apparently restricted to a few localities in Tenerife, and only one specimen from a natural locality has been seen (Burchard 39); according to Garcia Cabezon (in litt.)

Agua Garcia is now the principal locality for this taxon on Tenerife. Other specimens have been cultivated at Orotava, some apparently germinating spontaneously from seed in heather earth brought down from 'the mountains above Orotava' and others from seed from plants in natural localities, at La Mortola, Barranco de Gracia and Agua Garcia. The taxon thus appears to have a rather restricted and perhaps relic status on Tenerife. Similarly, only one specimen (Lowe 117G) has been seen from Gomera, although Pitard and Proust (1909) cite several specimens with leaves 3-6 mm. long, from Roque de La Valle Hermoso and Barranco del Alaya, Gomera, as C. stenopetalus var gomeræ. From the short description given by Pitard and Proust these specimens should clearly be referred to T. spachiana. The Lowe 117G specimen from Gomera which has been seen differs from T. stenopetala in having shorter leaves (10 mm.) and petioles (6 mm.), leaflets more obovate (twice as long as broad) and longer bracteoles (1.5 mm.). In all characters the specimen resembles T. spachiana.

Although individual characters such as leaf size, standard indumentum etc., tend to intergrade between T. canariensis and T. spachiana, it has been considered preferable to retain the latter taxon as an albeit rather doubtful species on the following grounds:

- (1) on overall facies specimens of T. canariensis and T. spachiana from the Canary Islands can usually be fairly readily distinguished;
- (2) the curious distribution of spachiana merits further investigation;

(3) on morphological grounds, the possibility exists that T. spachiana represents a hybrid situation between T. stenopetala and T. canariensis, although the occurrence of spachiana on Gomera presents serious difficulties to such an interpretation. It is considered that such problems are more likely to attract the attention of future field workers in the Canary Islands if spachiana is retained as a species for the present; if treated as a subspecies of T. canariensis (which in many ways would be no more satisfactory than retaining T. spachiana as a species) these problems might continue unnoticed. The reader is referred to the discussion of T. stenopetala, T. spachiana and T. canariensis limits in section II (p. 24).

A number of names for ornamental specimens which are commonly employed in the horticultural trade appear to refer to T. spachiana or to hybrids involving T. spachiana and either T. canariensis or T. stenopetala. These are discussed more fully in section II.

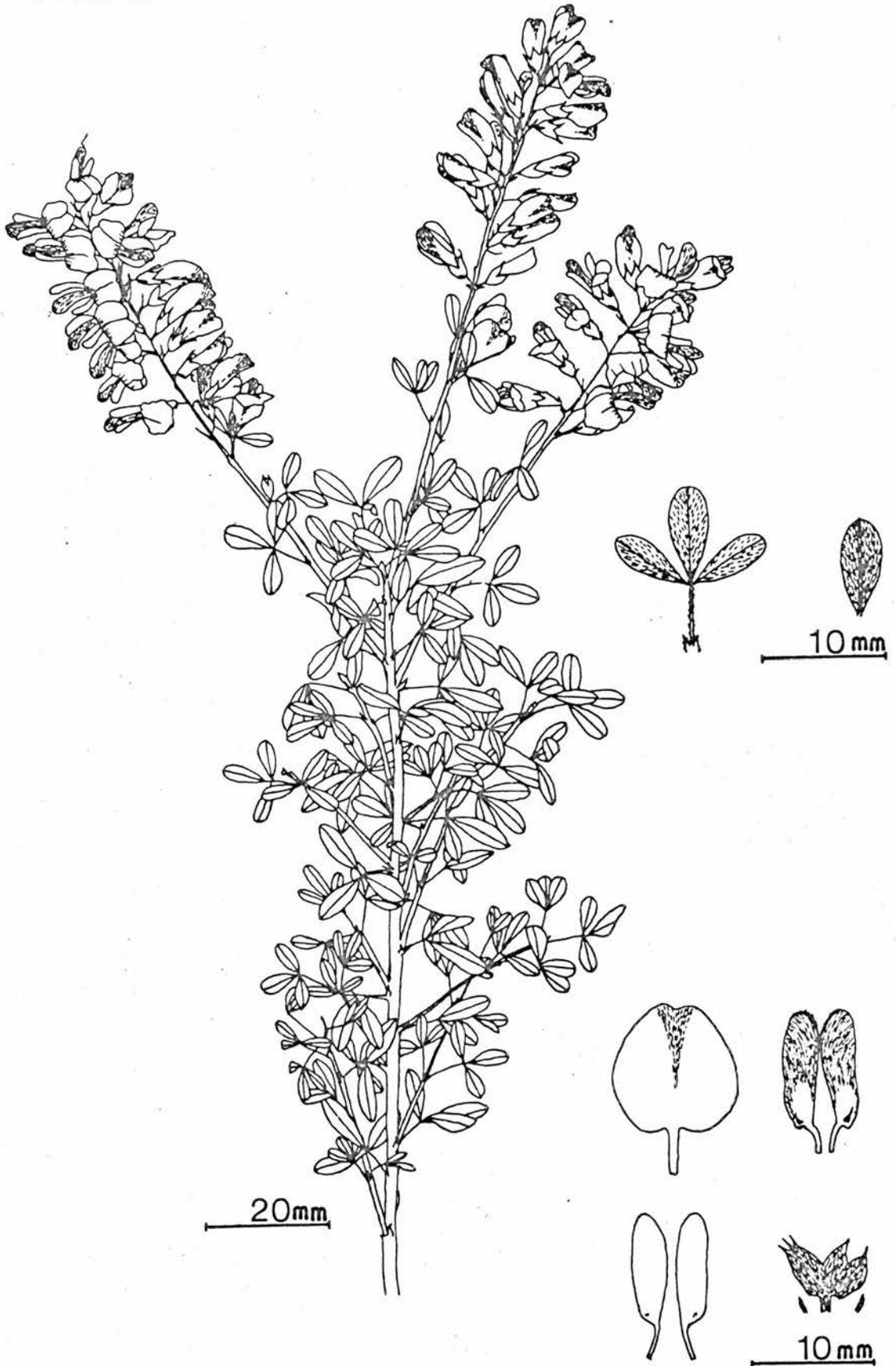
Fig. 19: T. spachiana

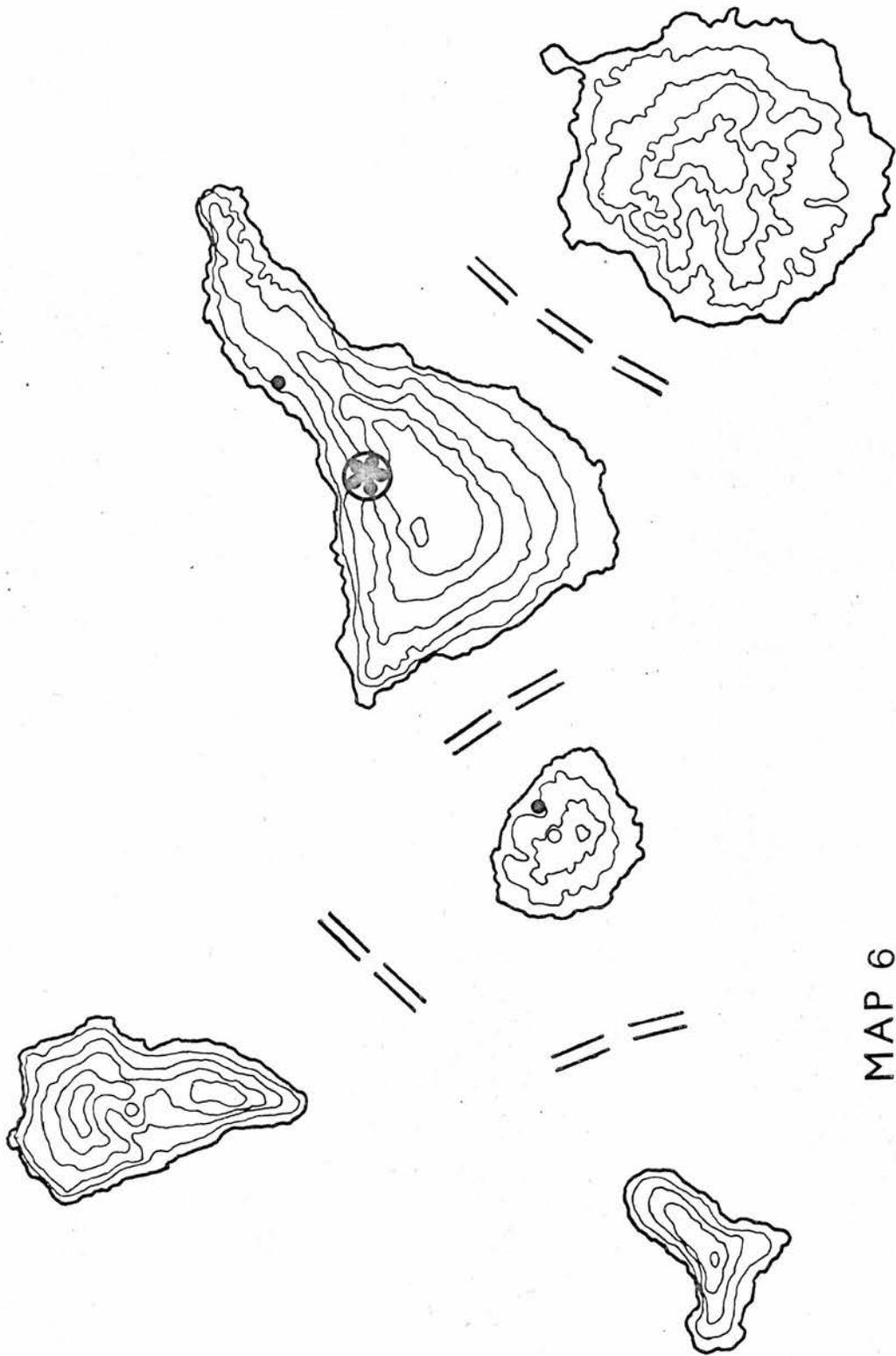
(source material: for illustration, 'cult.,
from Tenerife', V. 1904, Gamble 28899, K;
for corolla dissection: Tenerife, cultivated
at the Jardim d'Acclimatacion, Puerto Oro-
tava, 9. III. 1912, Perez, K)

Map 6 (overleaf): Distribution of T. spachiana

○ localities reported in the literature

FIG. 19





MAP 6

4. T. microphylla (D.C.) G. & D.¹, comb. nov. ined.

Syn. Genista microphylla D.C. Prodr. 2: 146 (1825) excl. syn.

Teline congesta W. & B. Phyt. Canar. 3(2): 40 (1842),
excl. syn. Spartium congestum Willd.

Cytisus congestus (W. & B.) Ball, Jour. Linn. Soc. Lond.
(Bot.), 16: 404 (1878).

Much-branched shrub, up to 2 m.; branches congested, with a very dense, short, whitish-brown, tomentose indumentum; internodes short. Leaves trifoliolate, petioles 1-3.5 mm.; leaflets 3-6 x 1.5-3.5 mm., narrowly to broadly elliptic, markedly involute, appearing sub-linear, apex acute; leaflets densely tomentose on both surfaces, or sometimes patent-pubescent above; petiolule 0-0.2 mm., indistinct; stipules 0.5-1.2 mm., triangular, slightly obtuse at the apex. Inflorescence 5-23 mm., determinate, flowers 4-8. Bracts subtending the lowermost (2-4) flowers sub-foliaceous, trifoliolate, those of the upper flowers much reduced, simple; pedicels 1-2 mm.; bracteoles (2) 1-1.5 mm., linear to lanceolate, borne at the base of the calyx. Calyx 3.5-5.5 mm., whitish-brown tomentose, the upper teeth triangular, somewhat obtuse, the lower teeth short, sometimes indistinct. Standard 9-12 mm., ovate, entire or emarginate, the outer surface sericeous along the midvein towards the apex. Keel adpressed-pubescent. Legume 10-15 x 3-5 mm., narrowly oblong, densely tomentose. Fl. January - June.

Ecology: dry roadsides, mountain sides, barrancos, cumbres, calderas. c. 900 msm.

¹Gibbs & Dingswall

Distribution: Canary Islands. Gran Canaria (map 7).

Type: Ayacata, Chr. Smith (Herb. D.C. ? not traced).

Icon: fig. 20; also Webb & Berthelot, tab. 42 (1836).

ISLAS CANARIAS

GRAN CANARIA: Cumbre supra San Mateo, 1900, Bornmüller 466 (LD); Cumbre, Roque del Saucillo, 1901, Börn Müller (LD); Barranco de la Angostura, IV. 1846, Bourgeau 398 (MANCH, K, E); Cumbre de Tiraxana, 1855, Bourgeau 1309 (MA, MANCH, K, E); Convalle de Tenteniguada, 900 msm., IV, 1924, Burchard 227 (E); without precise locality: Desprès (K); Webb (K, MANCH).

Specimens varying towards T. canariensis:

near Tafira, 14. V. 1900, Bornmüller 465 (LD); Convalle del Drac de Mar, III. 1846, Bourgeau 810 (K); Caldera de Bandama, Murray (K); near Tafira, 11. V. 1890, Murray (K); without precise locality, 1875, Lowe (K).

Specimens intermediate between T. microphylla and T. canariensis:

Atalaya, 'in declivibus', 25. VI. 1931, Frey & Stora (H); Santa Brigida, III. 1933, Trethewy 164 (K).

Obs. Nomenclature of T. microphylla

Webb and Berthelot (1842) recognised this species under the name Teline congesta citing the basionym Spartium congestum Willd., although the illustration of congesta (W. & B. loc. cit., tab. 42, published in 1836) was titled 'Genista microphylla Chr. Smith'.

Spartium congestum Willd. was published as a footnote to a unifol-

foliate series of species in Enum. Hort. Berol.: 744 (1809) with the following protologue:

'S. ramis teretibus striatis confertissimis floribus terminalibus racemosis, vexillis glabris, carina pubescente, foliis lanceolatis sericeis. Habitat in Teneriffa, Cl. Broussonet. Differt a S. virgato: ramis tenuioribus, confertissimis, foliis angustioribus, floribus brevissime pedunculatis, vexillis glaberrimis'.

This taxon is thus a unifoliolate species from Tenerife referable to Genista virgata Ait. or Cytisus tener Jacq.

The earliest epithet referable to the species Teline congesta sensu Webb & Berthelot, which is restricted to Gran Canaria, is Genista microphylla D.C. (Prodromus 2: 146, 1825), where the species is accurately described and the specimen 'Ins. Canar., Ayacata, Cl. Chr. Smith' is referred to. However, De Candolle (loc. cit.) cited Spartium microphyllum Cav. (Anales de Ciencias Naturales 10 (4): 62, 1801) as a possible synonym (ie. basionym) for his Genista microphylla. It has not been possible to trace the type specimen of Spartium microphyllum Cav., collected by Broussonet, but the protologue (loc. cit.) refers to a species from Tenerife, with densely fasciculated leaves and legumes with tubercles. These characters, particularly the latter, suggest that Spartium microphyllum Cav. refers to a species of Adenocarpus, probably A. foliosus (Ait.) D.C. Thus Genista microphylla D.C. remains the basionym for this species.

Affinities with T. canariensis

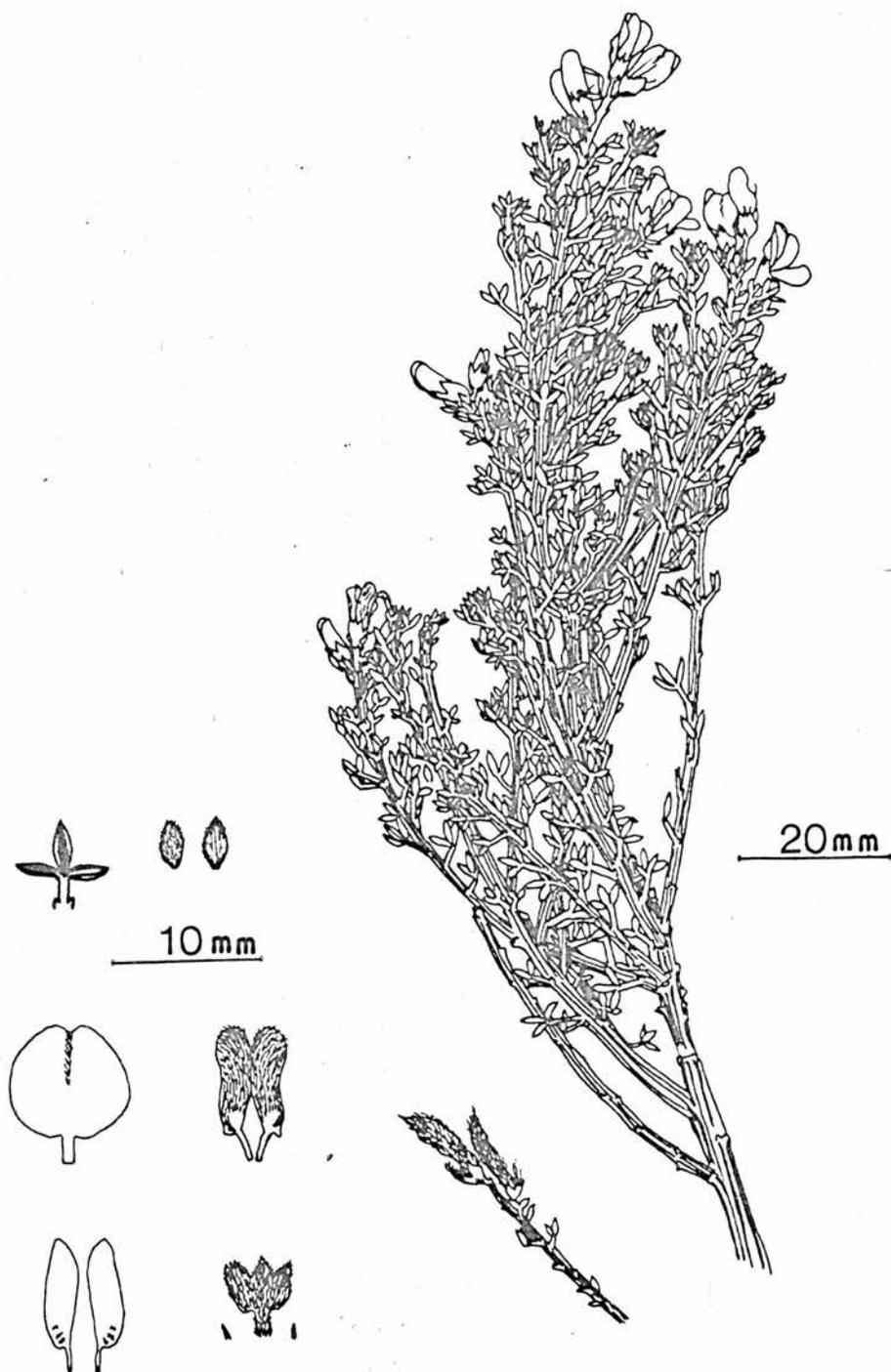
Although some specimens appear to vary towards T. canariensis, in most cases T. microphylla is easily distinguished from T. canariensis by its dense, short, tomentose indumentum, elliptic and markedly involute leaves, shorter racemes and nearly glabrous standard petal. Two specimens (Frey & Stora, Trethewy 164) however, are not easily referable to either T. canariensis or T. microphylla, since they are completely intermediate. These may be interpreted either as intermediates between partially diverged races, or as the result of hybridisation, with some introgression of T. canariensis into T. microphylla, and vice versa. The latter appears a more likely explanation as the intermediates are so few in number; since these are in the minority it is considered preferable to retain the two taxa as separate species. It is interesting in this context that two Trethewy specimens (157 and 164) which are very similar and are both from Santa Brigida, are labelled C. canariensis and C. congestus: although no intermediate situations between T. microphylla and T. canariensis have been mentioned by previous authors, at least one collector has found difficulty in referring some specimens to either of the two species.

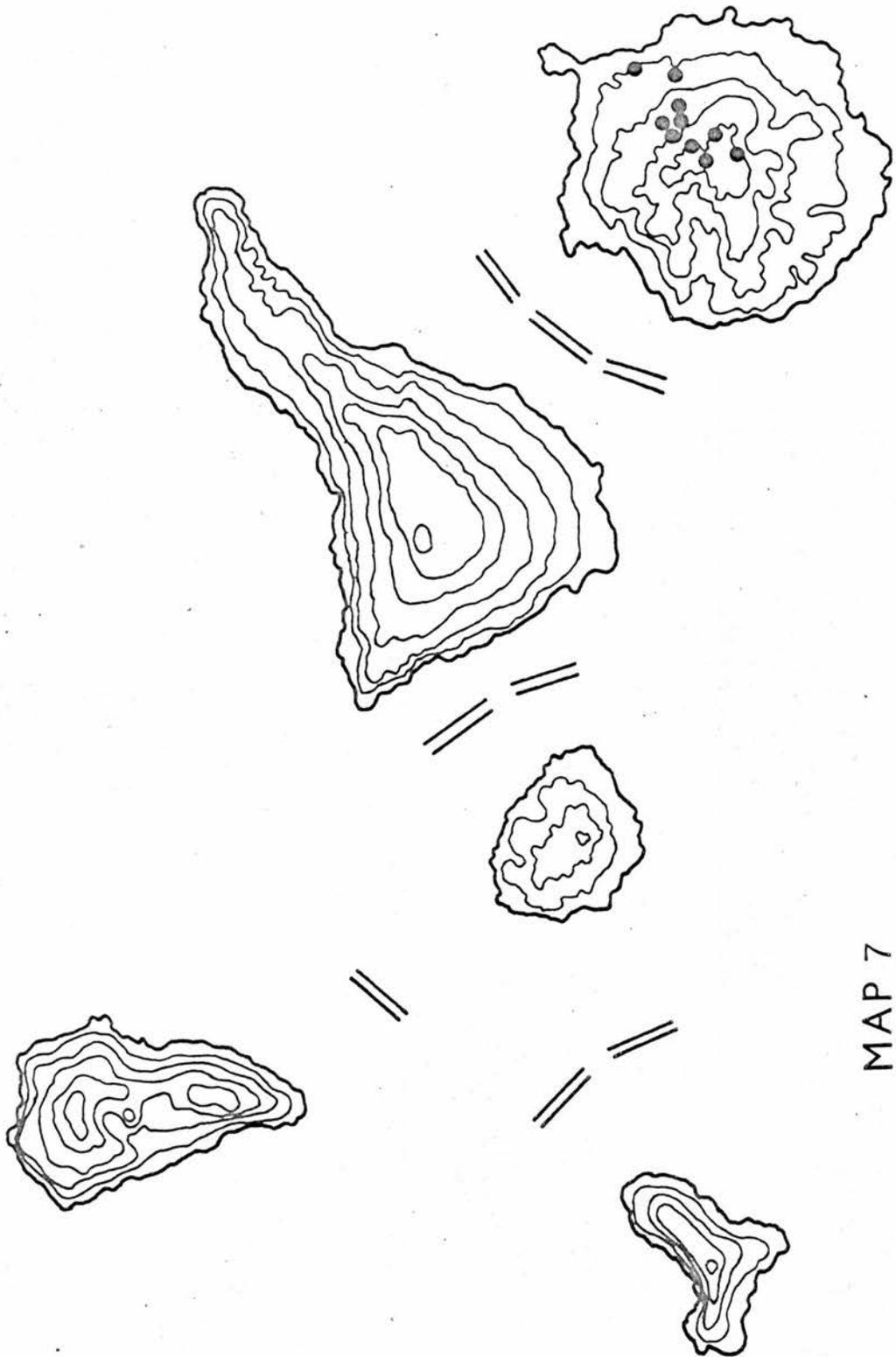
Fig. 20: T. microphylla

(source material: for illustration, Gran
Canaria, Barranco de la Angostura, IV. 1846,
Bourgeau 398; for corolla dissection, Gran
Canaria, Cumbre, Roque del Saucillo, 1900,
Bornmüller 466, LD)

Map 7 (overleaf): Distribution of T. microphylla

FIG. 20





MAP 7

5. T. paivae (Lowe) G. & D., comb. nov. ined.

Syn. Genista paivae Lowe, Man. Fl. Mad. 1: 125 (1868).

Cytisus paivae (Lowe) Masf., Anal. Soc. Esp. Hist. Nat.
10: 149 (1881).

Erect, branching shrub up to 2 m.; branches and twigs subglabrous, or sparsely sericeous. Leaves trifoliolate, petioles 4.5-9.5 mm.; leaflets 8-16 x 4-8 mm., oblanceolate to obovate, apex obtuse to acute, mucronulate; leaflets glabrous to sparsely adpressed-sericeous above, more densely so below, with short fine white hairs; petiolule 0.4-1.0 mm.; stipules 0.7-2.3 mm., acute. Inflorescence 20-60 mm., determinate, a raceme of 8-16 flowers. Bracts subtending the lowermost (0-2) flowers usually sub-foliaceous trifoliolate, those of the upper flowers much reduced, simple; pedicels 2.1-3.5 mm.; bracteoles (2) 0.5-1.0 mm., linear, borne at the base of the calyx. Calyx 4-5 mm., densely adpressed sericeous, with short hairs, upper teeth acute, lower teeth minute (0.1-0.3 mm.) and indistinct. Standard 9.0-12.5 mm., broadly ovate, emarginate or entire, glabrous. Keel shortly adpressed-sericeous, becoming glabrous near the claw. Legume 19-35 x 3-3.5 mm., narrowly oblong, densely woolly-sericeous, indumentum short. Fl. April - June.

Ecology: seacliffs, margins of woodland. 100-150 (-1500?) msm.

Distribution: Madeira (map 8).

Type (syntypes): Fajãa d'Ovelha, IV. 1860, Lowe G41 (K); Pto.

do Pargo, Lowe (K).

Icon.: fig. 21.

MADEIRA

Arco del Jorge, Sr. Moniz, V-VII. 1860, Lowe 359X (K); Fajãa d'Ovelha, IV. 1860, Lowe G41 (K); Pto. do Pargo, Lowe (K); Cameo Central, Sr. Moniz, 28. VII. 1860, Lowe 359X (K); between S. Vicente and Seixal by the Ribeira Delgada, 1. IV. 1865, Lowe (K); Ribeira de Metada, Malhada Velha, 1000-1500 msm. (? may refer to specimen of T. maderensis on same sheet), IV-X. 1865-6, Mandon 53 (E); Pto. do Pargo, 100-150 msm., IV-X. 1865-6, Mandon 54 (K); without precise locality: 1855, Lowe 163 (COI, K); 1856, Mason (MANCH).

Obs. This species is readily distinguished from T. maderensis by its short white adpressed indumentum, minute mucro (0.1-0.3 mm.), short stipules, bracteoles and calyx, and lower calyx lip with minute and indistinct teeth.

T. paivae resembles T. spachiana in general facies, but may be distinguished by the glabrous standard, short calyx and indistinct calyx lower lip teeth of the former. Some of the larger specimens of T. paivae also approach T. stenopetala but they have shorter petioles, leaflets and flowers than the latter species.

Fig. 21: T. paivae

(source material: for illustration, Madeira, Pto. do Pargo, Mandon 54, E; smaller fragments, Madeira, Ribeira de Metada, Malhada Velha, IV - X, 1865-6, Mandon 53, E; for corolla dissection, Madeira, 1865, Lowe, K)

Map 8 (overleaf): Distribution of T. paivae and
T. maderensis

● T. paivae

▲ T. maderensis

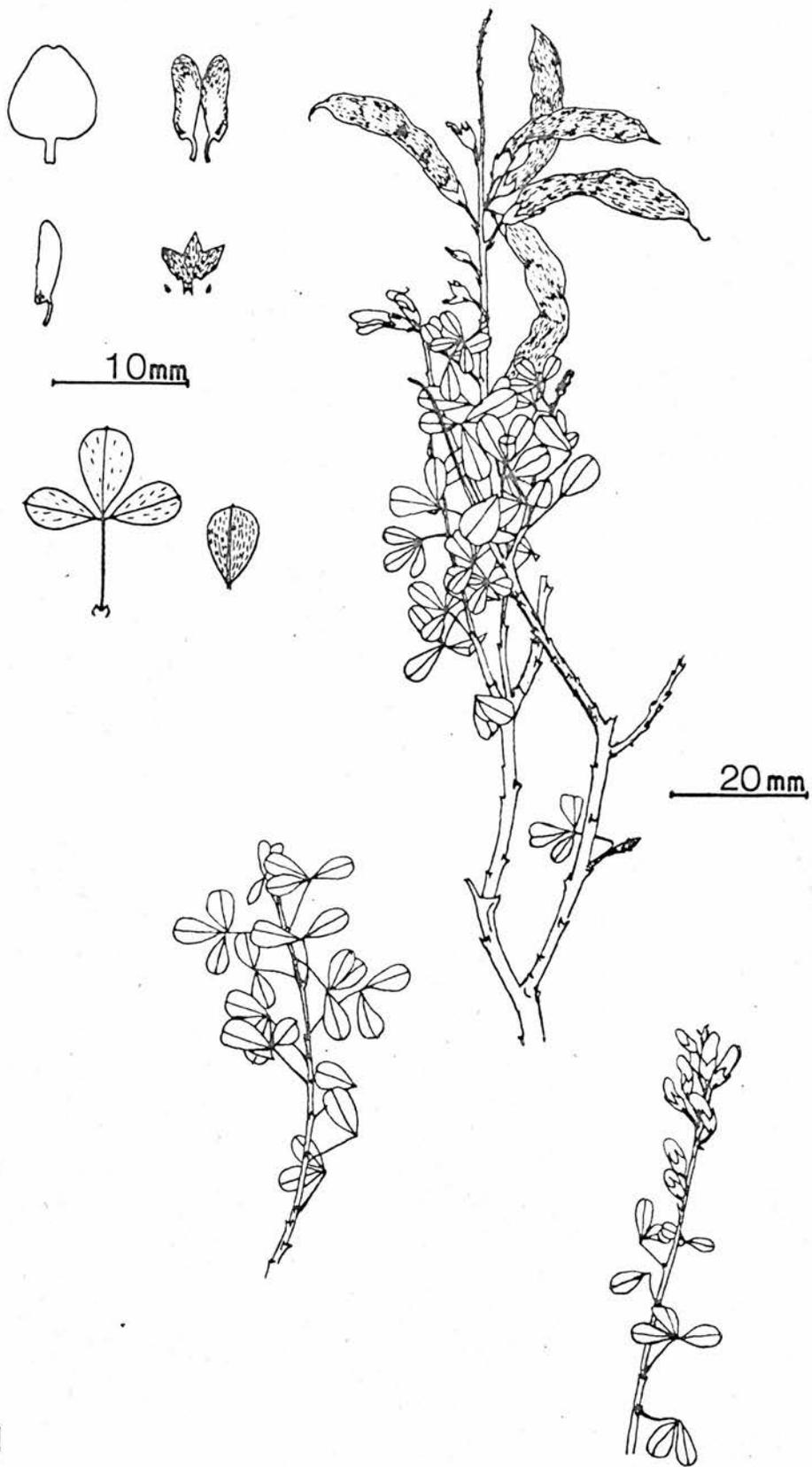
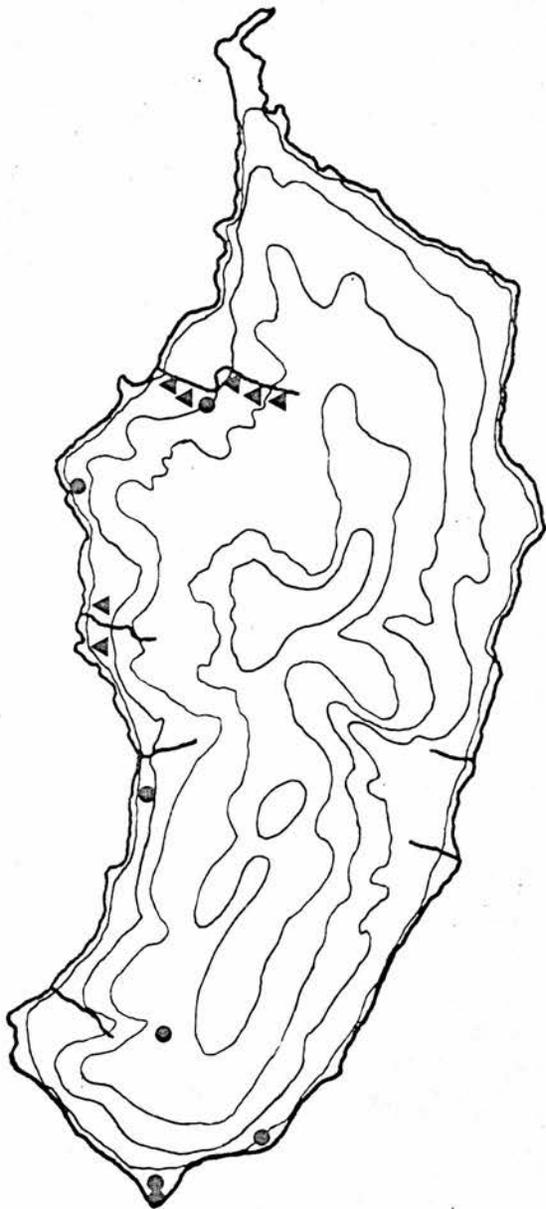


FIG. 21



MAP 8

6. T. maderensis W. & B., Phyt. Canar. 3(2): 37 (1842).

Syn. Cytisus candicans Holle, Flora 13: 388 (1838), non L.

Genista candicans Webb, Iter Hisp.: 50 (1838).

? Genista canariensis Buch, Abhandl. der K. Akad. Berl.
no. 385 (1866), non L.

Genista maderensis (W. & B.) Lowe, Man. Fl. Mad. 1: 125
(1868).

Cytisus maderensis (W. & B.) Masf., Anal. Soc. Esp.
Hist. Nat. 10: 149 (1881).

Erect shrub, up to 2 m.; branches and twigs densely villous, ferruginous. Leaves trifoliolate, petioles 7-10 mm.; leaflets 13-15 x 5.5-10 mm., obovate to oblanceolate, apex acute, mucronate (mucro 0.4-0.6 mm.); leaflets villous-velutinous, sparsely so above, \pm densely below, hairs ferruginous; petiolule 0.5-1.0 mm.; stipules 4-6 mm., linear lanceolate. Inflorescence 15-35 mm., determinate, a raceme of 5-15 flowers. Bracts subtending the lowermost (2) flowers sub-foliaceous, trifoliolate, those of the upper flowers much reduced, simple; pedicels 2.5-4 mm.; bracteoles (2) 2.0-4.5 mm., linear. Calyx 5-7 mm., villous-velutinous, ferruginous; upper teeth cuspidate, lower teeth distinct, long, linear. Standard 14-15 mm., broadly ovate, slightly emarginate, glabrous. Keel uniformly sericeo-pubescent. Legume 19-35 x 4-8 mm., narrowly oblong, densely villous-velutinous, ferruginous. Fl. April - July. Ecology: shady sides of rocks, steep wooded banks and ravines, 900-1500 msm.

Distribution: Madeira (map 8).

Type: Ponta Delgada, Webb: n.v.

Icon: fig. 22.

MADEIRA

Ribeiro Frio, 900 msm., 27. VII. 1900, Bornmüller 457 (LD); Boaventura, Torrinas, Bornmüller 455 (LD); Ribeiro Frio, VII. 1862, Clarke (K); Ribeiro Frio, Ribeira de Metada, Malhada Velha, 1000-1500 msm., IV-X. 1865-6, Mandon 53 (K, E); Ribeiro Frio, 25. V. 1847, Mason (LD); Ribeiro Frio, 29. VI. 1827 (? Webb) 359 (BM); Ribeiro Frio, 6. XII. 1830, (? Webb) (K); without precise locality, Lowe (K).

Obs. T. maderensis has large very conspicuous sheathing stipules, which distinguish it from all other species. The leaves of this species are apparently somewhat fugaceous and the persistent and prominent stipules give the twigs a rather scaly appearance.

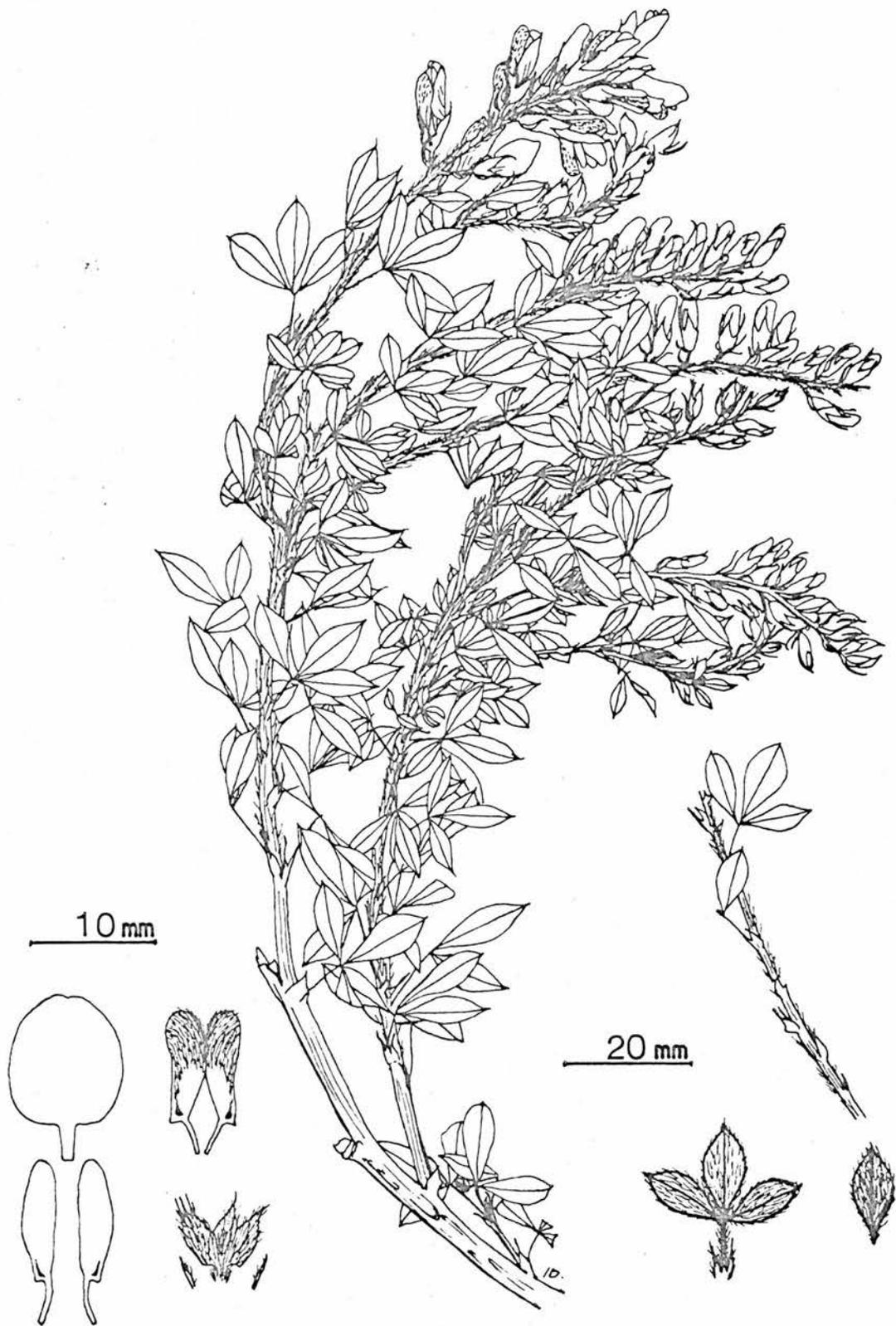
Like T. monspessulana, herbarium specimens of T. maderensis have a ferruginous indumentum; no recently collected material has been seen, but Lowe (1868) states that on plants collected by him the indumentum was ferruginous, so that, unlike T. monspessulana, this appears to be characteristic of the living plant¹ and not merely of old dried specimens (see observations under T. monspessulana, p. 78).

¹ However, according to Grabham (1934), T. maderensis has a silvery white indumentum, which suggests that specimens, as with T. monspessulana, become brown with age.

Fig. 22: T. maderensis

(source material: for illustration, Madeira,
Lowe, K; for corolla dissection, Madeira,
Ribeiro Frio, VII. 1862, Clarke, K)

FIG. 22



7. T. monspessulana (L.) Koch, in Dendrologie 1: 30 (1869).
- Syn. Cytisus monspessulanus L., Sp. Pl. ed. 1, 2: 740 (1753).
- Genista candicans L., Amoen. Acad. IV: 284 (1759).
- Cytisus candicans (L.) var. Lam., Encycl. Méth. Bot.,
2: 248 (1786).
- Teline medicagoides Med., Vorles. Churpf. Phys. Ges.,
2: 342 (1787).
- Cytisus pubescens Moench., Meth. Suppl. : 43 (1802).
- Cytisus candicans (L.) D.C., in Lam. & D.C., Fl. Fr.,
ed. 3, 4: 504 (1805).
- Telinaria candicans (L.) Presl, Bot. Bemerk. : 49 (1844).
- Genista syriaca Boiss. & Blanche, Diagn. Pl. Or. Nov.,
ser. 2, 2: 8 (1856).
- Cytisus syriacus (Boiss. & Blanche) Boiss., Fl. Or.,
2: 55 (1872).

Erect, much-branched shrub up to 2.5 m.; branches sub-glabrous, twigs densely villous to patent-pubescent. Leaves trifoliolate, petioles 0.8-3 mm., leaflets 5-13 x 2.2-9 mm., obovate to oblanceolate, with sparse to dense adpressed or spreading hairs on both surfaces, sometimes sub-glabrous above; petiolule 0.3-0.5 mm.; leaflet apex entire or slightly retuse, usually mucronulate; stipules 0.5-1.5 mm., linear-lanceolate. Inflorescence 1.5-6 mm., indeterminate, flowers in dense clusters of 4-7 at the end of short lateral branches. Bracts subtending the lowermost (2-3) flowers sub-foliaceous, trifoliolate, those of the upper flowers much reduced, simple; pedicels 1.5-3.0 mm.; bracteoles (2) 0.5-1.0 mm., linear, borne at the base of the calyx. Calyx 4-7 mm.,

patent-pubescent; upper teeth acute, lower teeth usually minute and indistinct. Standard 10-13 mm., broadly ovate, glabrous, apex entire. Keel \pm uniformly adpressed-pubescent. Legume 15-25 x 3-5 mm., narrowly oblong, densely hirsute-lanate. Fl. February-June.

Ecology: rough open scrub, on sea shores, stream banks, roadsides, mountainsides, 1-3500 msm. (mainly 300-800 msm.); on schist, granite and siliceous rock.

Distribution: Mediterranean region (most common in Spain and North Africa, slightly less frequent in France, Sardinia, Corsica and Sicilia, and locally in Italy, Greece, Turkey and Syria); Portugal; Atlantic coast of Morocco; Azores (map 9).

Type: Sauvage 191, n.v.; also no. 892.2 (Savage Catalogue, 1945) in the Linnaean herbarium (LINN).

Icon: fig. 23.

PORTUGAL

Cintra, Mn. Ferrat, 4. IV. 1846, Trevelyan (K).

SPAIN

CADIZ: Algeciras, La Trocha, 9. VI. 1851, Ball (E); Ronda, 3500', V. 1837, Boissier (K); Los Barrios, 700', III. 1957, Brinton-Lee (K); Algeciras, slopes of Sierra de Palma, 16. V. 1924, Ellman and Hubbard 597 (K); Algeciras, 19. IV. 1926, Lindberg 716 (K); Algeciras, Sierra de Palma, IV. 1895, Porta and Rigo (MANCH);

Ronda, III. 1867, Redhead (MANCH); Algeciras, 23. IV. and 4. VII. 1887, Reverchon 22 (K); between Vejer and Sierra de Palma, 0-2000', 21. III. 1845, Willkomm 593 (K); Sierra de Palma and Algeciras, Willkomm 593A (K, E); Algeciras, 15. IV. 1896, Winkler (K).

VALENCIA: Montserrat, 1884, D'a Guimaraes (COI).

BARCELONA: Moncada, Pyrénées Espagnoles, V. 1897, Bourgeau 323 (K); Tibidabo, Casa Ferrer, 28. IV. 1918, Sennen (COI); Tibidabo, 19. V. 1920 (K); 7. IV. 1926, 16. IV. 1927, 14. VII. and 14. VIII. 1929, Sennen (COI); mountains, V. 1860, Mill (K).

GIBRALTAR

Europa Point, 1848, Hurst 145 (MANCH); El Cobre, 20. III. 1913, Perez 1643 (K); waterfall, 3. II. 1913, Perez 1557 (K); near Mill Soto, Calpes, 26. II. 1913, Wolley-Dod 1610 (K).

ISLAS BALEARES

MAJORCA: IV., Todaro (MANCH).

FRANCE

VAR: Cote de Montdardier, 27. IV. 1878, Anthonard (MANCH); Hyères, IV. 1928, Buller (K); Forêt des Maures, Butler (K); Grasse, 1963, Gavelle (COI); Forêt des Maures, Jordan (K); Toulon, Girodet (E); Hyeres, V. 1839, Kugel (E); Hérault, 6. V. 1880, Neyraut (LD); St. Andres, Bois de Loumet, near Narbonne, 26. V. 1901, Neyraut (MANCH); Port Vendre, 1854, Penchinat & Schultz (COI, K, MANCH); Banyeuls sur Mer, 1. VI. 1850, Penchinat 523 (MANCH).

CORSIKA

Ajaccio, 29. III. 1914, Adamson (MANCH); Bastia, 8. IV. 1914, Adamson (MANCH); Bastia, Cardo, 10. III. 1869, 16. VII. 1869, Alebreau (MANCH); Ajaccio, 29. III. 1848, Bourgeau 96 (K); Zicaro, IV. 1899, Collet (K); Bastia, Cardo, 10. VI and 10. VII. 1866, Debeaux & Mabilie (K); Bastia, 12. II. 1917, Forsyth H297.32 (K); Villa Pietrofanto, 27. IV. 1889, Petit (COI); Sierra de Scopamène, par Sartène, 2. VI. 1879 and 3. VII. 1879, Reverchon 211 (MANCH, K); Bonifacio, 18. V. 1880, Reverchon 211 (MANCH, E); Bonifacio, II. 1910, Stefani (MANCH); Colvi, VII. 1929, Wyatt 107 (K); without precise locality, IX. 1822 Salzmann (K); Thomas (E).

ITALY

PISA: Etrusca, Gattajola, Lucchèse (E); Pisa, 1968, Van Hueck (MANCH, K).

CAMPANIA: Napoli, Val de S. Rocco, 1845, Alexander (E); Inarime, near Napoli, VI. 1842, Ball (E); Astrone, near Napoli, 26. IV. 1841, de Heldreich (E); Napoli, Woods (K).

SARDINIA

Tempio, IV. 1901, Gamble 20276 (K); Tempio, 2000', V. 1901, Gamble (K); Laconi, 1827, Müller (K); Santa Teresa Gallura, Tempio, 9. III. and 29. VI. 1881, Reverchon (MANCH); 16. IV. and 29. VI. 1881, Reverchon (MANCH, E); 17. IV. and 30. VI. 1881, Reverchon (K); 7. V. and 10. VII. 1881, Reverchon (K); brondissement de Tempio', 7. IV. and 15. VII. 1882, Reverchon (MANCH).

SICILIA

Messina, 29. III. and 3. V. 1898, Dörfler 37 (K); 18. IV. 1877, Huter, Porta & Rigo 10 (MANCH, E, K); III. 1855, Mill (K); 1-1000 msm., VI. 1905, Zodda 867 (K); without precise locality, Alexander (E).

GREECE

EUBOEA: Steni, 27. VI. 1958, 300-800 msm., Rechinger 19180 (K).

SAMOS: between Agios Konstantinos and Nenethes, 100 msm., 6. IV. 1934, Rechinger 3769 (BM, K).

ALBANIA

H. Apostolas, Teresa, 18. VII. 1895, Baldacei 30 (K).

TURKEY

Istanbul, Aydos, 1. IV. 1951, Berk (E); Izmir, north side of Samsun Dag, above Guselcamli, 200-400 msm., 24. IV. 1965, Davis 41774 (E); Aydin, Samsun Dag, 30 km. south of Daviltar, north side, 200 msm., 24. V. 1962, Dudley (E); Izmir, Kusadasi, Samsun Dag, 9. V. 1965, Kayacik & Yaltirik 3356 (E); Istanbul, Sariyer, Belgrad Ormani, 20. VIII. 1960, Yaltirik 1396 (E); Belgrad Ormani, 13. V. 1958, Yaltirik (E).

SYRIA

LEBANON: Sanin, supra Biskinta, 15. VI. 1897, 15-1600 msm., Bornmüller 322 (K, E); Ain Zahalta, 13-20. VI. 1910, 12-1300 msm.,

Bornmüller 11604 (BM, E); Hasrun, Lowne (BM, E); without precise locality, 1863-4, Lowne (K).

ALGERIA

ALGIERS: Ain Telagi, Blidah, VII. 1844, Capiomont, (K); Blidah, 15. VII. 1851 and 15. VI. 1855, Durando (MANCH); Bouzareah, Hurst 79 (MANCH); Bouzareah, 1. III. and 27. IV. 1851, Jamin 143 (K); Prairies de la Chiffa, près Blidah, 29. III. 1861, Lefebreo (BM); Air Talazid, près Blidah, 28. III. 1879, Meyer (K).

ORAN: Ferme des Andalous, Oran, 6. III. 1852, Balansa (K); Forêt de M'Sila, near Oran, IV. 1922, D'Alizette (LD); El Ancor, Forêt de M'Sila, 10. IV. 1922, Faure 1.297 (LD); Terny, Tlemcen, 1300 msm., 29. VI. 1930, Faure (E, LD, K); Zemmora, Forêt d'Harcha, 1000 msm., 2. V. 1927, Jahandiez (E).

MOROCCO

Tangier, 1849, Boissier & Reuter (E); Tangier and Tetuan, IV. 1871, Hooker (K); Tangier, I. 1883, Kersten (MANCH); Tangier, 25. IV. 1926, Lindberg (H); Djebel Kebir, Tangier, 15. VII. 1926 Lindberg 1579 (H); 19. IV. 1911, Pitard 782 (K); Cap Spartel, 20. IV. 1911, Pitard 777 (K); Djebel Kebir, Tangier, 24. III. 1916, Roffey (K); Tangier, IV. 1825, Salzmann (K), and 20. II. 1839, Salzmann (LD); El Harcha, Montes Zaian, 5. V. 1936, Samuelson 7419 (LD); Tangier to Cap Spartel, 28. IV. 1936, Simpson, 3.6.561 (K); Tangier, I. 1931, Trethewy (K); Cap Spartel, c. 100', 28. II. 1960, Whiting & Richmond 122 (K).

AZORES

INSULA SAO MIGUEL: Fermo da Lagoa, 1905, Carrecio 1066 (COI).

INSULA FLORES: Santa Cruz, Monte, Stora & Lagerskog 36 (H); without precise locality, or collector: 'in collibus hortorum insulis Azoria, quasi-spontanea V. and VI. 1838, G. & H.' (K).

Cultivated and naturalised material

CANARY ISLANDS: Tenerife, Villa Orotava, 25. III. 1914, Perez (K).

BRITAIN: Hyde Park, 13. V. 1933, Hay (K); Highfield, Lyss, Hants, VIII. 1905 and VII. 1906 Gamble (K); Hort. Bot. Kew., 31. V. 1935, McAlister-Hall (K); Millford, S. Hants, V-VII. 1914, Melvill (K); Hort. Bot. Kew., Temperate House, VI. 1966, Smith H2137/66 (K); Claverly, Wolverhampton, 20. V. 1967, Wood H1748/67 (K); without collector, as 'type for Bot. Mag. t. 8685', 16. IV. 1914 (K).

RUSSIA: Hort. Bot. Petropolitano, rec'd. 1867 (K).

INDIA: Ootacamund, Nilgiris, 19. IV. 1905, Bourne 477 (K); Nilgiris, III. 1870, Clarke (K), and 1. IV. 1870, Clarke 11773 (BM); Nilgiris, 1851, Hohenacker 1206 (BM,K); Peninsula Indiae Orientalis, rec'd 1866-7, Wight 577 (K).

JAVA: 10. X. 1911, Buijsman (K).

AUSTRALIA: Melbourne, IX. 1953, no. 138, without collector (K).

NEW ZEALAND: Kaori, Kisk 905 (K).

Obs. Several authors have recognised T. monspessulana from different parts of its range as distinct species. Boissier and Blanche (1856) referred specimens of T. monspessulana from the Lebanon to a new

species, Genista syriaca (subsequently transferred to the genus Cytisus). According to these authors the species differed from G. candicans L. (ie. C. monspessulanus L.) in having more slender twigs and branches, with a patent indumentum, and acuminate leaves. Four specimens from Syria have been seen, (Bornmüller 322, 11604; Lowne, Hasrun, and without precise locality, 1863-4), but no type material. Of these, only the Bornmüller 322 from Edinburgh appears notably distinct; there is a tendency for the other specimens to differ slightly in these characters. However, the specimens from Syria are not distinct enough to merit recognition at either species or subspecies level; they possibly merit varietal status, but this decision cannot ^{easily} be made on the strength of only one significantly different specimen among four from the same area.

Specimens from Algeciras, Spain, were recognised as another species, Genista eriocarpa Kuntze (1846), and Willkomm and Lange (1880) followed this treatment when they transferred the species to the genus Cytisus as Cytisus kunzeanus. The species differs from T. monspessulana in having a wide, curved legume with a whitish-woolly indumentum, whereas T. monspessulana has a straight, narrow, brownish-woolly legume. Some Willkomm specimens from Algeciras (also Huter, Porta and Rigo, Algeciras, and Redhead, Ronda) show the distinguishing characters mentioned above; they also differ in possessing a longer first internode on lateral shoots and broader leaflets than typical T. monspessulana. In the specimens from Syria there is also a tend-

ency for the first internode of lateral shoots to be long, but in this case the leaflets are narrower than those of typical T. monspessulana. As with the specimens from Syria, C. kunzeanus Willk. and Lange possibly merits varietal status but so few specimens have been seen that the taxonomic situation is not clear.

The possible occurrence of T. monspessulana in the Canary Islands presents an enigmatic situation. Webb and Berthelot (1842) included T. monspessulana (as T. candicans var. subspicata) in their account of the Canary Island species of Teline, stating 'Ad margines sylvarum in montosis borealibus teneriffae rarior. Specimena nostra legimus prope sylvam Agua Garcia'.

Pitard and Proust (1909) describe T. monspessulana from Tenerife as 'très rares dans l'époque des Phytographia Canariensis' and cite a single locality, Agua Mansa. However, García Cabezon (in litt.) has recently stated that T. monspessulana does not occur on Tenerife.

A single specimen of typical T. monspessulana from Tenerife has been seen at the herbarium of the Royal Botanic Gardens, Kew. This was prepared from a plant in cultivation at Orotava, which apparently grew spontaneously from seed in 'brezo' earth brought down from the mountains above Orotava (Perez, 25. III. 1914, K). Further, two specimens have been seen from Agua Mansa (1. VII. 1900, Bornmüller 458, LD; Hamilton, E), which were originally determined as C. canariensis but which both show some monspessulana-

like characters, viz. a dense villous-ferruginous indumentum, large leaves with a relatively short petiole, and indeterminate inflorescences. In other respects, eg. sericeous standard and shape and size of bracteoles, these specimens resemble T. canariensis.

With such fragmentary records it is only possible to conjecture as to the status of T. monspessulana in the Canary Islands. Possibly the species was until recent times naturally distributed in Tenerife, and the records by Webb and Berthelot and Pitard and Proust represent relic specimens of such a distribution. Alternatively, the sporadic occurrence of plants of T. monspessulana may represent introduction from the Mediterranean area since the Spanish colonisation of the archipelago in the sixteenth century.

Certainly the Perez cultivated specimen at Orotava, if its origin from natural seeds in brezo earth is correct, indicates that 'typical' monspessulana has been present on Tenerife in very recent times; the anomalous Bornmüller and Hamilton specimens noted above could represent hybridisation between T. monspessulana and T. canariensis. (In this context it must be pointed out that Agua Mansa is only a very short distance from the garden at Orotava and that plants from the Mediterranean are known to have been cultivated there. It is possible that the specimens at Agua Mansa are the result of hybridisation of Mediterranean T. monspessulana, as opposed to native T. monspessulana, with T. canariensis).

T. monspessulana has been reported from Central Portugal (Coutinho, 1913), Central Spain, Madrid (Cutanda, 1861), and from the north-east coast of the Black Sea / Sea of Azov, in the Krasnodar region (Grossheim, 1952). No specimens have been seen from these areas, and it is not known if T. monspessulana is naturally distributed there. The localities reported in literature are entered as open circles in the distribution map for T. monspessulana (map 9).

Most herbarium specimens of T. monspessulana have a ferruginous indumentum, which is not found with recently collected specimens from California, or with plants in cultivation. This coloration therefore appears to be an ageing characteristic of T. monspessulana, particularly since specimens of comparable age of some other species (eg. T. stenopetala, T. paivae) are not ferruginous. Three other species have a ferruginous indumentum: in T. canariensis and T. osmariensis, like T. monspessulana, it appears to be characteristic of age of collected specimens, but in T. maderensis, according to Lowe, it is characteristic of the living plant.

T. monspessulana is the only species with an indeterminate inflorescence and consequently the only species to continue growth on the flowering shoots, in the same season, after flowering. The leaves of such post-flowering shoots differ in shape from those formed earlier, being more lanceolate with an apiculate apex.

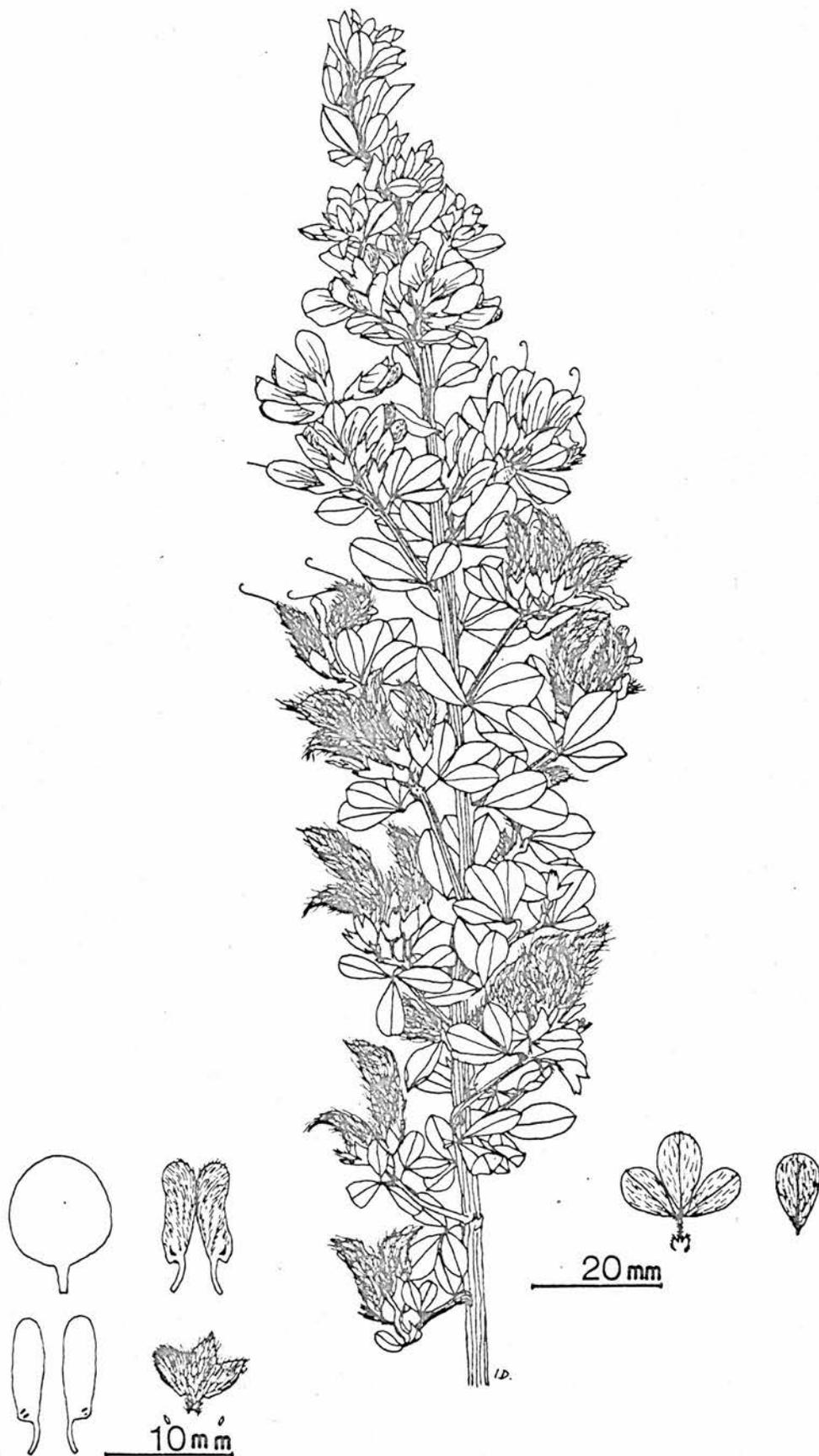
Fig. 23: T. monspessulana

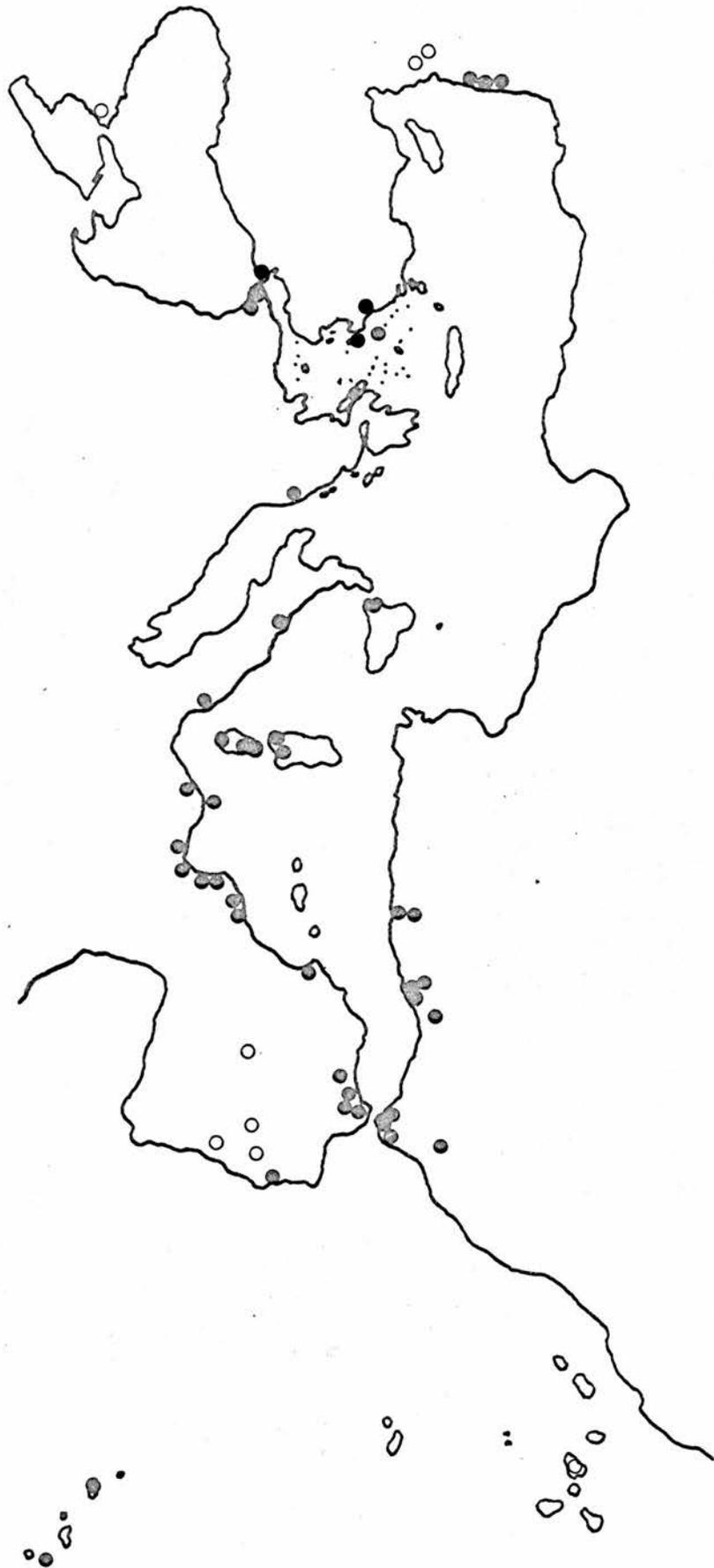
(source material: for illustration, Morocco,
'in collibus tingitanis', 20. II. 1839,
Salzmann, LD; for corolla dissection, Algeria,
Oran, Forêt de M'Sila, D'Alizette, LD)

Map 9 (overleaf): Distribution of T. monspessulana

(o localities reported in the literature)

FIG.23





MAP 9

8. T. linifolia (L.) W. & B., Phyt. Canar. 3(2):42 (1842).

Basionym Genista linifolia L., Sp. Pl. ed. 2, 2:997 (1763).

Erect shrub, up to 2.5 m.; branches sub-glabrous to moderately densely adpressed-pubescent. Leaves trifoliolate, sessile or shortly petiolate (0-6.5 mm.); leaflets 9-61 x 2-10.5 mm., linear to narrowly oblong or elliptic, revolute, with sparse to dense adpressed white hairs above, more densely so below; apex obtuse to acute, mucronate; stipules (when present) 1-6 mm., linear. Inflorescence 2-30 mm., determinate; flowers in dense clusters, more rarely racemes, of 4-20. Bracts subtending the lowermost (1-2) flowers sub-foliaceous, trifoliolate, those of the upper flowers much reduced, simple; pedicels 2.5-7 mm.; bracteoles 0.6-12.5 mm., linear, borne at the base of the calyx. Calyx 5.5-15 mm., densely sericeous, the upper teeth acuminate-cuspidate, the lower teeth distinct and long, with the median generally narrower than the lateral teeth. Standard petal 10-16 mm., narrowly ovate, emarginate, densely pubescent to sericeous on the outer surface. Keel \pm uniformly adpressed-pubescent, sericeous. Legume 15-33 x 4-6 mm., broadly oblong, densely hirsute-woolly or adpressed-sericeous. Fl. January - July.

Ecology: maquis, on hillsides, streambanks, woods, seashore, 80-1000 m., mainly on calcareous rock.

Distribution: Mediterranean region (common in Spain, Gibraltar, France, Morocco and Algeria; rare in the Balearic Islands, Italy

and Syria); Central Spain and Portugal; Atlantic coast of Morocco north of Rabat; Canary Islands.

Type: no. 892.5 (Savage Catalogue 1945), Alstroemer 185, at the Linnean herbarium (LINN).

Five subspecies are recognised:

A. Leaves sessile, exstipulate

B. Petiolule 1-2.5 mm.; legume hirsute-lanate

subsp. linifolia (i)

B'. Petiolule 0.3 mm.; legume puberulous

subsp. rosmarinifolia (iv)

A'. Leaves petiolate, or at least subsessile, always stipulate

C. Bracteoles 7-12.5 mm.; calyx 9-15 mm.

subsp. pallida (ii)

C'. Bracteoles 2.5 - 4.5 mm.; calyx 6.5-8 mm.

D. Leaves longer than 25 mm.; petiole longer than 2 mm.

subsp. teneriffae (iii)

D'. Leaves longer than 35 mm.; petiole longer than 5 mm.

subsp. gomeræ (v)

i) subsp. linifolia

Syn. Cytisus linifolius (L.) Lam., Encycl. 2:249 (1786).

Genistoides linifolia (L.) Moench, Meth. Suppl.:44 (1802).

Teline linifolia var angustifolia W. & B.,
Phyt. Canar. 3(2):42 (1842), pro parte.

Cytisus linifolius var angustifolius (W. & B.) Briq.,
Étud. sur les Cyt. des Alp. Marit.:140
(1894), pro parte.

Cytisus linifolius var. platyphyllus Briq.,
loc. cit.:140 (1894), pro parte.

Leaves sessile, exstipulate; leaflets 17-25 x 2-4.5 mm., linear, markedly revolute, apex obtuse to acute; petiolule 1.0-2.5 mm. Inflorescence 6.5-20 mm., flowers 6-16, in dense heads or sometimes racemes. Pedicels 3-6 mm., bracteoles 0.6-2.3 mm. Calyx 6-10 mm. Standard 10-14 mm., sericeo-pubescent along the veins on the outer surface. Legume 15-21 x 4-6 mm., densely hirsute-lanate. Fl. January - July.

Ecology: as for whole species.

Distribution: as for whole species, but absent in the Canary Islands (map 10).

Icon: fig. 24; also Bot. Mag. 13: tab. 442 (1799).

SPAIN

CÁDIZ: Alcala de los Gazules, 21. IV. 1849, Bourgeau (K, MANCH); Almoraima, north of Algeciras, 19. V. 1924, Ellman & Hubbard 686 (K); Algeciras, Sierra de Palma, 2 - 300 msm., 22. IV. 1895, Porta & Rigo 596 (K); Algeciras, 19. IV. and 12. VII. 1887, Reverchon 73 (K, MANCH, E); Sierra de Cartania, Algeciras, 3. V. 1888, Reverchon 73 (E); Algeciras, Sierra de Palma, 0 -2000', 22. III. 1845, Willkomm 582 (K).

MADRID: 1877, Laguna (MANCH).

BARCELONA: 15. IV. 1935, Mrs Cameron Paton H.758 (K).

GIBRAULTAR

Calpes Mountains, 4. VI. 1851, Ball (K, MANCH); Alameda, 1868,

Hurst, 146.7 (MANCH); Rock of Gibraltar, IV. 1880, Matthews (E); Montegno, 1825, Salzmann (K); without precise locality: VI. 1837, Boissier (K,E); Finlay (K); 1868, Hurst (MANCH); 1867, Kellert (K); 10. I. 1841, Leman (K); 12. VII. 1926, Lindberg 625 (MANCH); 1867, Redhead, (MANCH); 300', 7. V. 1957, Taylor (K).

ISLAS BALEARES

MINORCA: Mahon, 80 - 100 msm., 10. VI. 1885, Porta & Rigo (E, K, MANCH).

FRANCE

VAR: Carqueiranes, 1861, Bourgeau 25 (MANCH); Toulon, La Colle-Noire, 1859, Billot (MANCH); Ile Porquerolle, 1878, Gautier (MANCH); Iles Porquerolles, Gonan (K); Toulon, Gordon (MANCH); Bouzareu, IV. 1889, Hetourney (H, COI); Hyères (Iles Porquerolles), Ritorte, Jordan (MANCH); Toulon, IV. 1944, Jordan (K); Toulon, 10. VI. 1831, Maire (K); Hyères, 1889, Mouillifarine (COI); Ile Porquerolle, 1882, Robin (MANCH); St. Raphael, 23.IV. 1882, Robin (K, MANCH); Carqueiranes, 1861, Schultz 634 (K, MANCH); without precise locality 'alpibus gallicis', 1834, de Candolle (E).

ITALY

PISA: Pisa, Van Heuck (K).

SYRIA

LEBANON: 1894, Gaillardos (MANCH).

ALGERIA

ALGIERS: La Réghäia, IV. 1837, Bové (K); Birkadem, 1878, Caniz (MANCH); 1871, Cause (MANCH); Algiers, 1861, Durando (K); 1885, Durando (MANCH); Algiers, Gourlie (MANCH); Ténès, 1925, Hafstrom (LD); La Réghäia, 8. IV. 1914, Humbert (H); Birmadreis, Algiers, III-V. 1850, Jamin 21 (K, E); Algiers, 18. VII. 1861, Palmen (H); Birkadem, près Alger, 4. IV. 1860, Romain 986 (K); Pescada, Algiers, III. 1832, Schimper (E, K); 'ex montibus Algeriae', 1818, de Candolle (H).

ORAN: M. Sila, El Ancor, IV. 1922, d'Alizette (LD); Ferme des Andalous, près d'Oran, 1852, Balansa 399 (MANCH, K); M. Sila, El Ancor, 1922, Faure (LD), 11. VII. 1930, Faure (K) and 4. IV. 1939, Faure (E).

MOROCCO

Cap Spartel, 11. IV. 1939, Davis 404 (K, E); between Tangier and Méknès, IV. 1880, Miss Drummond-Hay; Tangier, IV. 1871, Hooker (K); Rabat, Forêt de Mamora, V. 1939, Irvine 3286 (K); Boulhaut, Chaonia, 20. IV. 1924, Jahandiez 149 (E, LD); Tangier, 1889, Kersten 22 (MANCH); Tangier 'in collibus', Lakman (LD); Cap Spartel, 12. II. 1926, Lindberg 1528 (H); Rabat, Forêt de Mamora, 2. V. 1926, Lindberg 1622 (LD, H); Tangier, Los Olivados, Lindberg 1507 (H); Rabat, Forêt de Mamora, VIII. 1887, Ritt (K); Tangier, IV. 1825, Salzmann (COI, LD, H, K); Rabat, Forêt de Mamora, 100', I. 1930, Trethewy (K); Tangier, IV. 1931, Trethewy 442 (K); Rabat, Forêt de

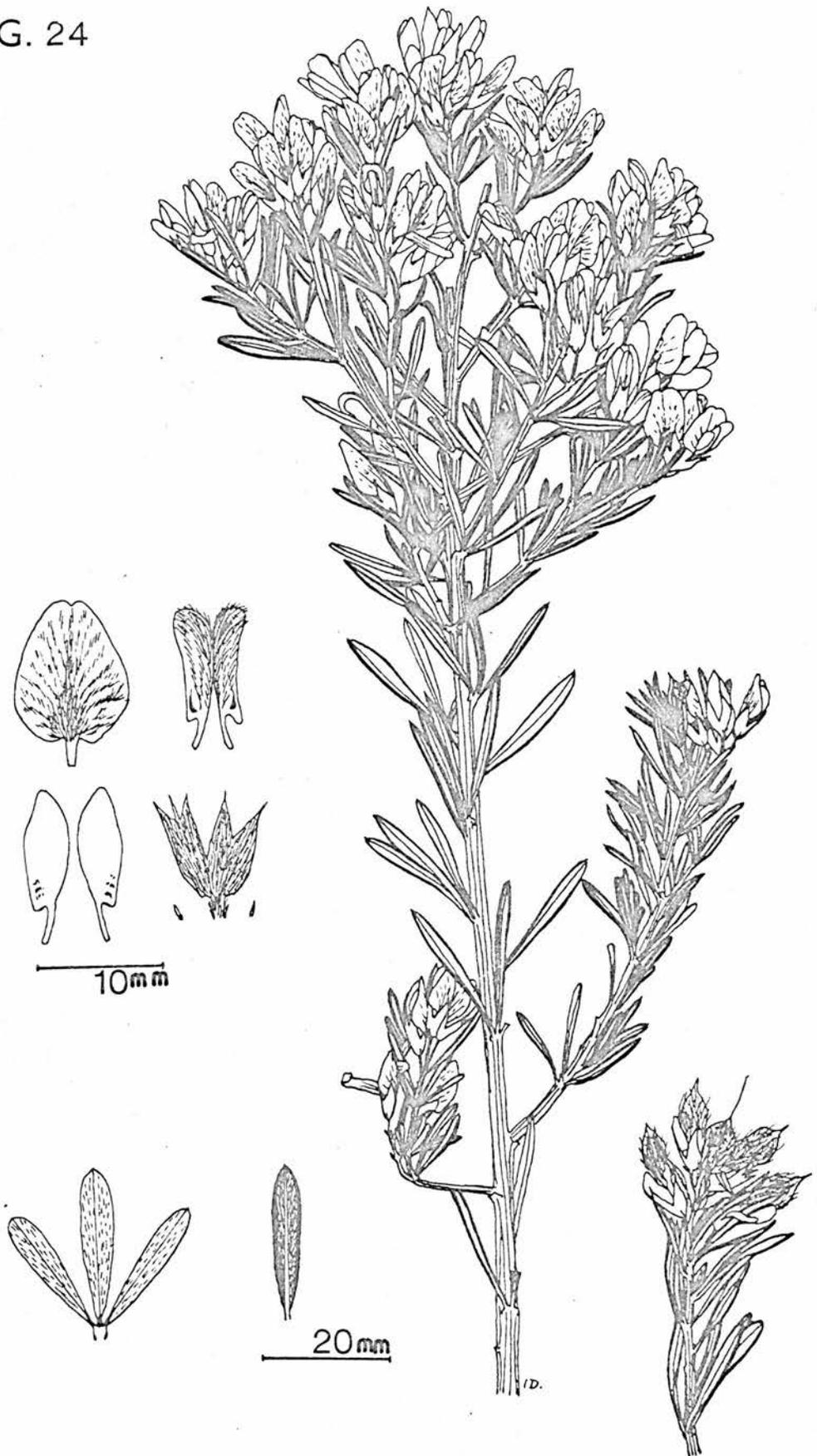
Fig. 24: T. linifolia subsp. linifolia

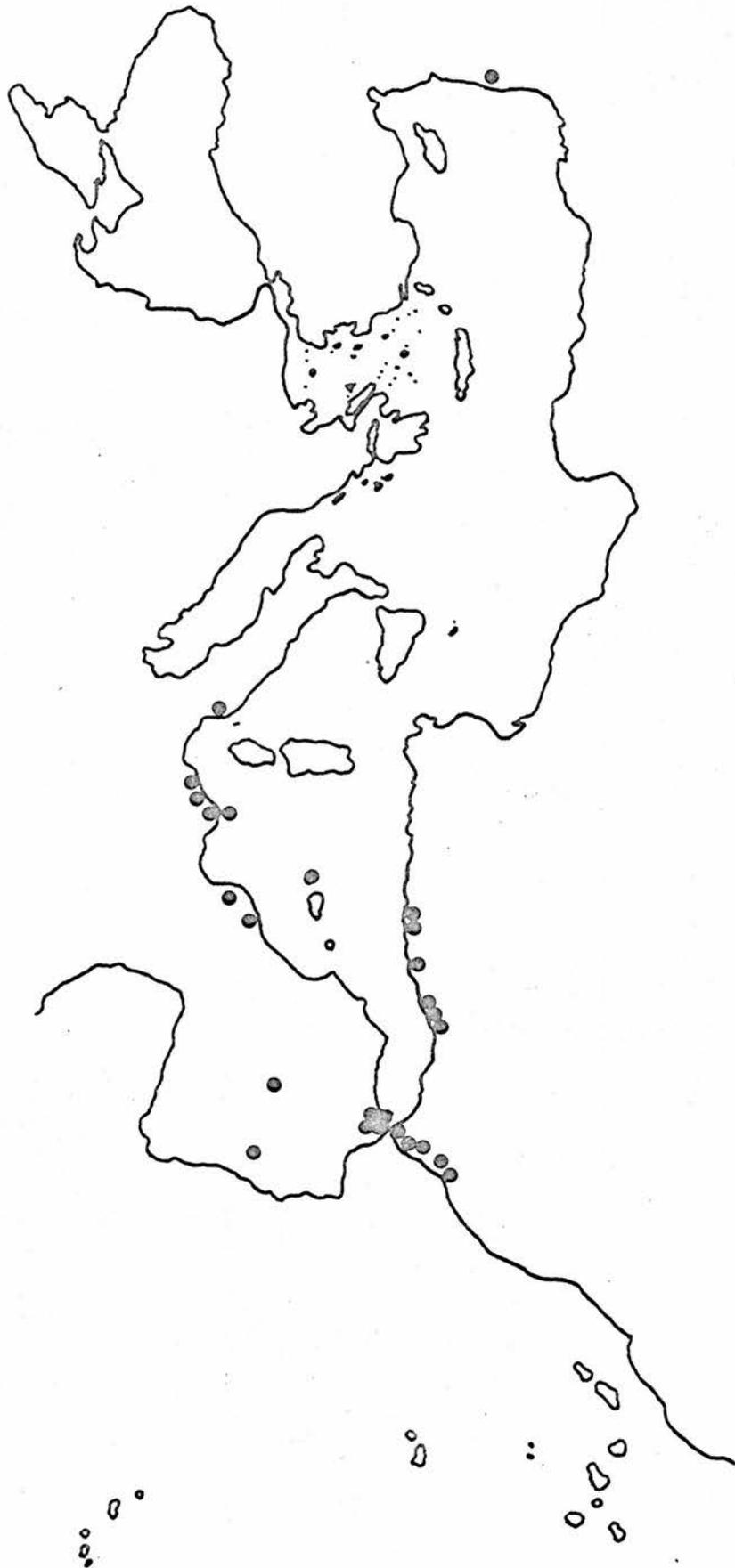
(source material: for illustration, Spain,
Alcala de los Gazules, 21. IV. 1849, Bourgeau
13, MANCH; for corolla dissection, France,
Carqueiranes, 1861, Schultz 634, MANCH)

Map 10 (overleaf): Distribution of T. linifolia subsp.
linifolia

(o localities reported in the literature)

FIG. 24





MAP 10

Mamora, 1837, Wall (LD).

Cultivated specimens

CANARY ISLANDS: Tenerife, Villa Orotava, rec.'d 1846, Bourgeau (K);

Villa Orotava, seed sent from France, 21. IV. 1913, Perez (K).

BRITAIN: 1880, Bishop Goodenough (K).

RUSSIA: Crimea, Yalta, Nikita Bot. Gard., Steven (H); without locality, Hassar (H).

ii) subsp. pallida (Poiret) G. & D., comb. et stat. nov. ined.

Syn. Cytisus pallidus Poiret, Encycl. Suppl. 1:442 (1817).

Genista splendens W. & B., Phyt. Canar. 3(2): tab. 43 (1836).

Teline linifolia var. latifolia W. & B., loc. cit.:42 (1842).

Cytisus linifolius var. pallidus Briq., Étud. sur les Cyt. des Alp. Marit.:140 (1894).

Leaves subsessile to petiolate, petiole 1.5-2.5 mm.; leaflets 29-61 x 4-11 mm., linear to narrowly elliptic, slightly revolute, apex acute; petiolule 1.5-2.2 mm.; stipules 2.3-6.0 mm., linear. Inflorescence 4-6 mm. (-60 mm. in cultivation), flowers in dense heads of 5-9. Pedicels 4-7 mm.; bracteoles 7-12.5 mm. Calyx 9-15 mm. Standard 14-16 mm., densely sericeous on the outer surface. Legume 28-33 x 4-5 mm., densely adpressed-sericeous. Fl. May - June. Ecology: valleys, 700 - 900 msm.

Distribution: Canary Islands. La Palma (map 11).

Type: Broussonet (herb. Desf. - not traced).

Icon: fig. 25; also Webb & Berthelot, loc. cit., tab. 43 (1836).

Fig. 25: T. linifolia subsp. pallida

(source material: La Palma, Convalle del
Rio, 1843, Webb)

Map 11 (overleaf): Distribution of Canary Island
subspecies of T. linifolia.

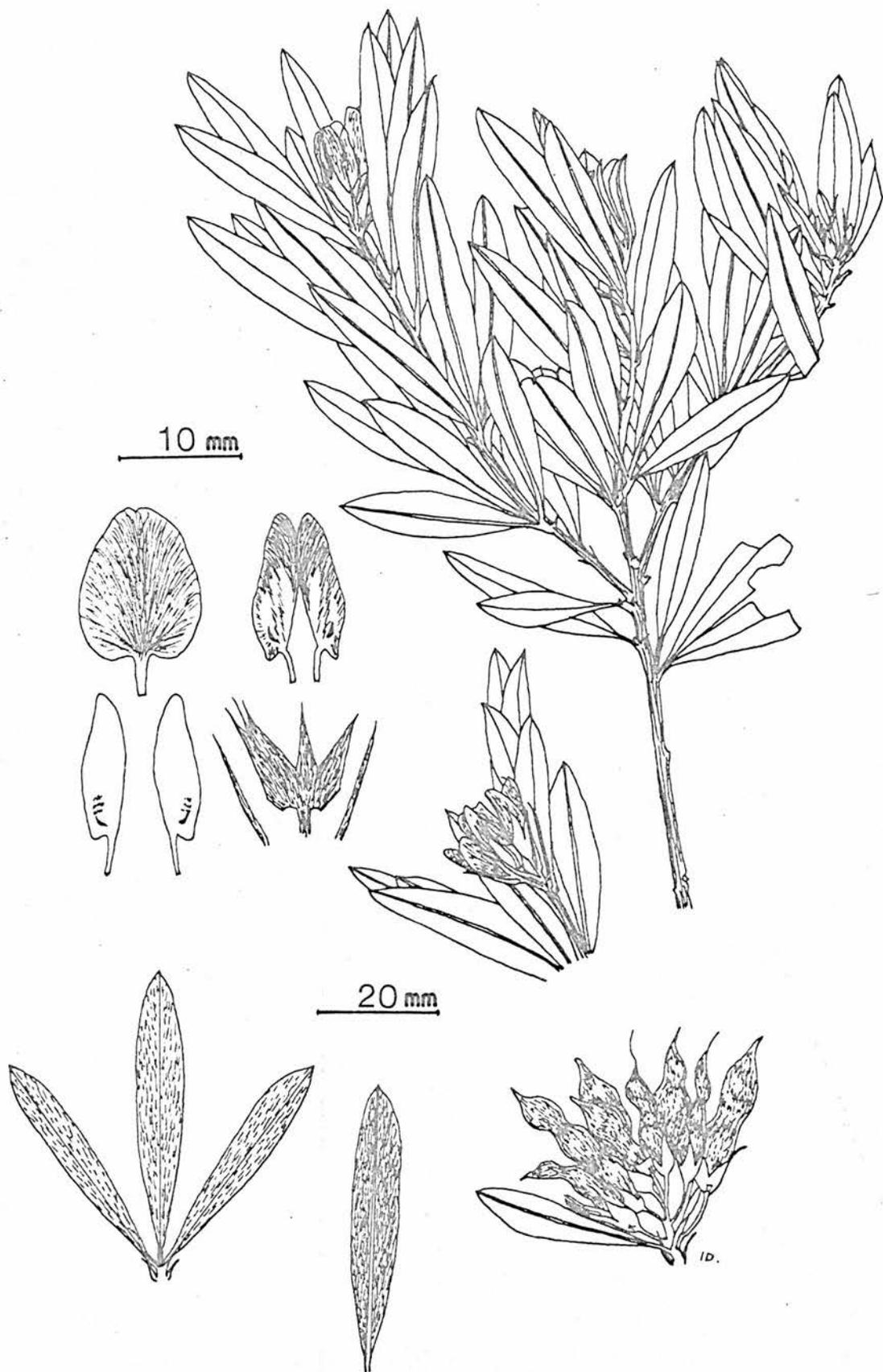
▲ subsp. pallida

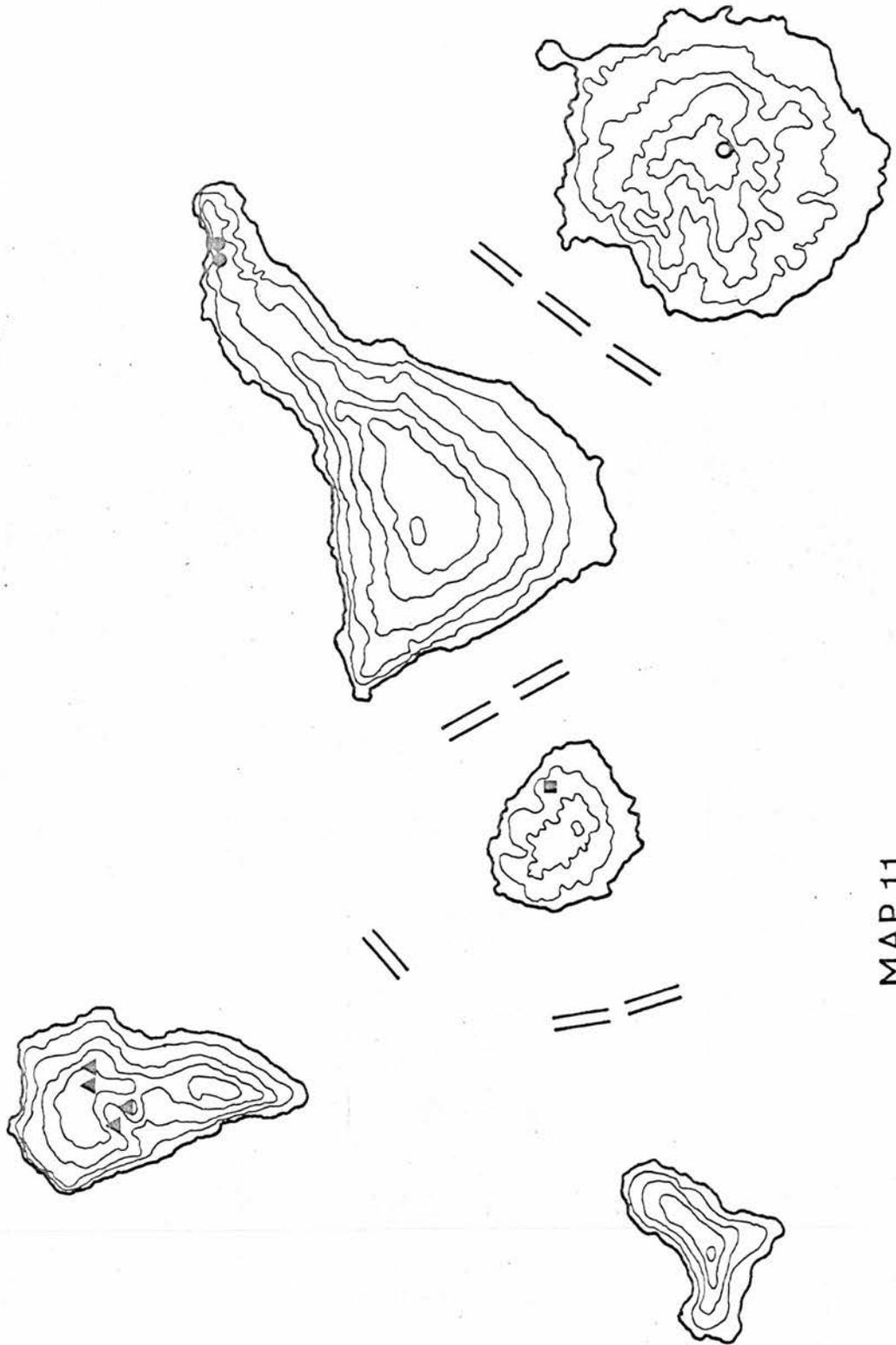
■ subsp. gomeræ

● subsp. teneriffæ

○ subsp. rosmarini-
folia

FIG. 25





MAP 11

LA PALMA

Convalle del Rio, 'in pinetis', 700 - 900 msm., V. 1924, Burchard 359 (E); Convalle del Rio, 1843, Webb (MANCH, K).

Cultivated material

SOUTH AFRICA: Cape Town, Kirstenbosch ('seeds sent from Lord Walsingham'), Pearson (K)

CANARY ISLANDS: Tenerife, Villa Orotava, 1912, 1914, Perez (K).

iii) subsp. teneriffae G. & D., comb. et stat. nov ined.

Syn. Cytisus linifolius var platyphyllus Briq., Étud. sur les Cyt. des Alp. Marit.:140 (1894), pro parte.

Teline linifolia var angustifolia W. & B., Phyt. Canar. 3(2):42 (1842), pro parte.

Leaves shortly petiolate, petiole 1.0-1.8 mm.; leaflets 16-20 x 4-5.5 mm., narrowly oblanceolate to oblanceolate, markedly revolute, apex obtuse; petiolule 1.1-2.1 mm.; stipules 1.0-2.3 mm., linear. Inflorescence 2-5 mm., flowers in dense heads of 6-12. Pedicels 3.5-4.5 mm.; bracteoles 3.0-4.5 mm. Calyx 6.5-8.0 mm. Standard 12.5-13.5 mm., densely sericeous on the outer surface. Legume 18-20 x 4-6 mm., densely adpressed-sericeous. Fl. March - June.

Ecology: scrub and woodland.

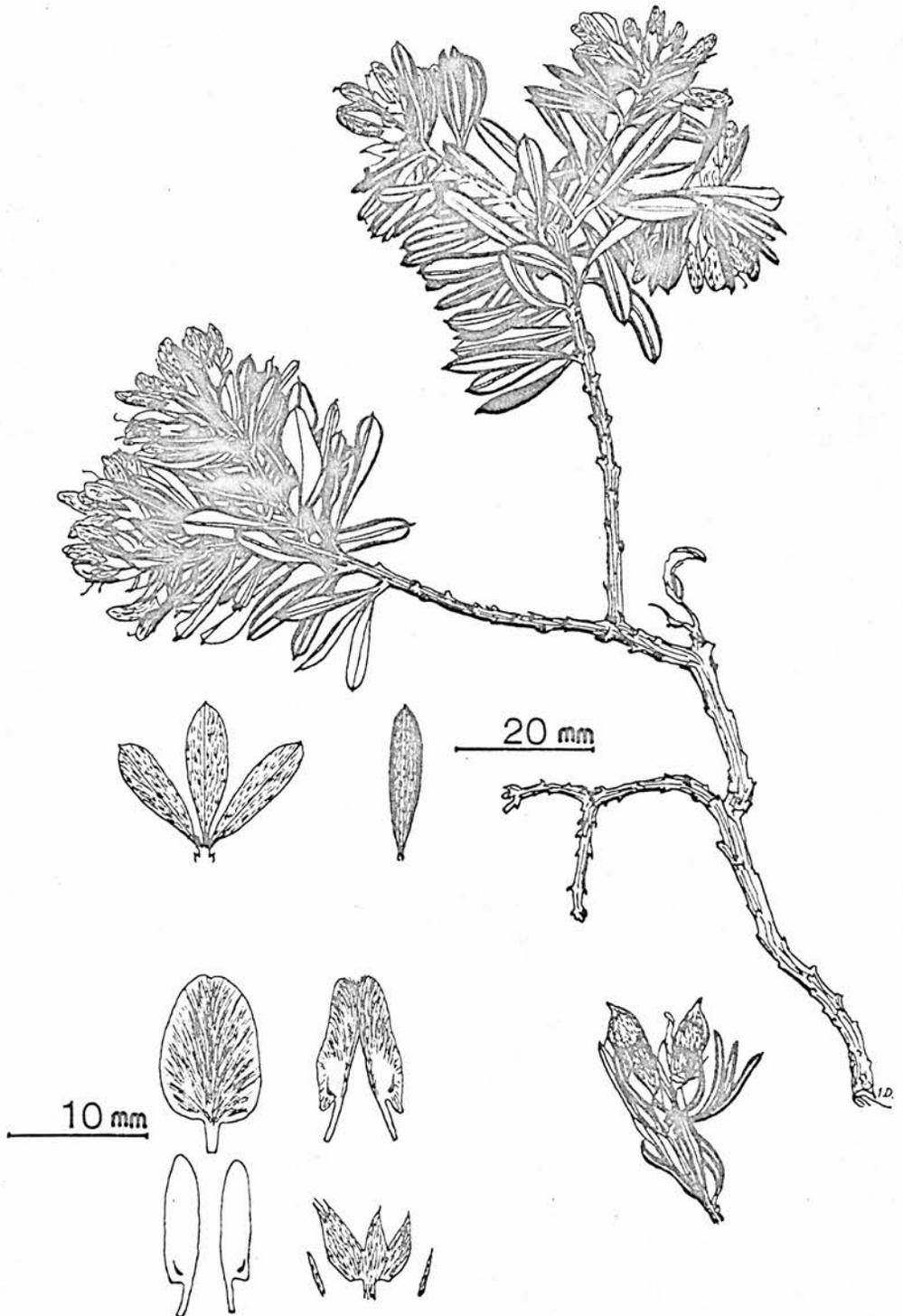
Distribution: Canary Islands. Tenerife (map 11).

Type: Tenerife, Taganana, 'in rupestribus altioribus sylvae', 28. III. 1855, Bourgeau 1303 (K).

Fig. 26: T. linifolia subsp. teneriffae

(source material: Tenerife, Taganana, 'in
rupestribus altioribus sylvae', VI. 1846,
Bourgeau 572, MANCH)

FIG. 26



Icon: fig. 26.

TENERIFE

Taganana, VI. 1846, Bourgeau 572 (MANCH, E); Taganana, 28. III. 1855, Bourgeau 1303 (K, LD, MANCH, E); without locality or date, Bourgeau (K).

iv) subsp. rosmarinifolia (W. & B.) G. & D., comb. et stat. nov.
ined.

Syn. Teline rosmarinifolia W. & B., Phyt. Canar. 3(2):43 (1842).

Cytisus linifolius var rosmarinifolius Briq., Etud. sur les Cyt. des Alp. Marit.:140 (1894).

Leaves sessile, exstipulate; leaflets 8-10 x 2 mm., linear - oblong, markedly revolute, apex acute; petiolule 0.3 mm. Inflorescence 4 mm., flowers in a short raceme of 4. Pedicels 2.5 mm., bracteoles 4.1 mm. Calyx 5.5 mm. Standard 10 mm., densely sericeous on the outer surface. Legume 17 x 5 mm., densely puberulous. Fl. April.

Ecology: cumbres, calderas.

Distribution: Canary Islands. Gran Canaria (map 11).

Type: Gran Canaria, El Risco Blanco Tiraxana, Despréaux (herb.

Webb ?) n. v.

Icon: Webb & Berthelot, loc. cit.: tab. 44 (1836); floral dissection only, fig. 8 (0).

GRAN CANARIA

El Risco Blanco Tiraxana, 1846, Bourgeau 399 (MANCH, BM, K, E).

v) subsp. gomeræ G. & D., comb. et stat. nov. ined.

Syn. Cytisus platyphyllus Hutch., nom. nud. (specimen in a type folder at herb. K).

Leaves petiolate, petiole 6.2 mm.; leaflets 44 x 9 mm., narrowly oblanceolate, slightly revolute, apex obtuse; petiolule 1.3 mm.; stipules 2 mm. Inflorescence 30 mm., a raceme of 20 flowers. Pedicel 4.0 mm.; bracteoles 2.5 mm. Calyx 6.5 mm. Standard 12.0 mm., densely sericeous on the outer surface. Legume unknown. Fl. April.

Ecology: cumbres.

Distribution: Canary Islands. Gomera. Only known from the type locality (map 11).

Type: Gomera, El Cumbre Hermigua, 19. IV. 1861, Lowe 183G (K).

Icon : floral dissection only, fig. 8 (Q).

Obs. The nomenclature and taxonomy of subspecies pallida, rosmarinifolia and linifolia (sensu G. & D.) is straightforward, but this is not the case with subspp. teneriffæ and gomeræ. Webb and Berthelot (1842) recognised two varieties under T. linifolia, var. latifolia (subsp. pallida G. & D.) and var. angustifolia. The latter appears to include both subsp. teneriffæ and subsp. linifolia, since it has a Mediterranean and Canary Island distribution, and is described as possessing linear leaves, usually without stipules. The only locality given by these authors for var. angustifolia is Taganana, which is the type locality for

subsp. teneriffae.

Briquet (1894) recognised four varieties under his C. linifolius: var. angustifolius (Mediterranean and Canary Islands), var. pallidus (Canary Islands. La Palma), var. platyphyllus (Mediterranean and Canary Islands) and var. rosmarinifolius (Canary Islands). Var. angustifolius Briq., although its distribution is Canary Island as well as Mediterranean, is described as 'always exstipulate' and therefore probably refers to subsp. linifolia (ie. the Mediterranean element) alone. Var. platyphyllus Briq. is more difficult to place. This variety is described as possessing leaves somewhat larger than var. angustifolia (20-30 mm. as opposed to 15-20 mm.), sometimes with stipules. It cannot refer to subsp. linifolia alone, since specimens of the latter never have stipules; however the leaf size does not correspond to that of either of the stipulate subspecies, gomeræ and teneriffae. Subsp. teneriffae has leaves generally shorter, and subsp. gomeræ has leaves very much longer, than subsp. linifolia. Var. platyphyllus Briq. remains ill-defined, therefore, in terms of the subspecies recognised in this account.

Hutchinson, in a note on the type folder containing the single specimen of subsp. gomeræ G. & D. (Lowe 183G), refers to Cytisus platyphyllus Hutch., Sp. nov., citing C. linifolius var. platyphyllus Briq. as the basionym. This species does not appear to have been published. Since the subspecies of T. linifolia occurring on the island of Gomera does not correspond to C. linifolius var. platyphyllus Briq., it would be unwise to retain

this name at subspecies level: a new name, subsp. gomeræ, is therefore proposed.

Rouy and Foucaud (1897) recognised four varieties of Genista linifolia, all Mediterranean in their distribution; these are all included in subsp. linifolia in the present account. The varieties are: genuina (syn. C. linifolius var. platyphyllus Briq. pro parte; leaves linear - oblong, 12 x 2-3 mm., obtuse; Algeria); grandifolia (syn. C. linifolius var. platyphyllus Briq. pro parte; leaves large, lanceolate - oblong, 31 x 2-5 mm., apiculate; Algeria, Hyères, Iles de Porquerolles, Port-Cros, Toulon, Carqueiranes); pinifolia (leaves narrowly linear, strongly revolute; Algeria) and angustifolia W. & B. (leaves linear, obtuse; Hyères, Iles de Porquerolles, Port-Cros, Toulon, Carqueiranes, Algeria). No specimens of subsp. linifolia appear to merit varietal status, and it is very difficult to interpret the varieties recognised by these authors.

Although T. linifolia is sympatric with almost all other Teline species in some part of its distribution, only two possibly hybrid situations have been found:

i) Two specimens mounted on the same sheet, from Ile de Porquerolle, Var (Köhler, MANCH) appear to be hybrids between T. linifolia subsp. linifolia and T. monspessulana: one specimen is almost exactly intermediate between the two species and thus appears to be an F₁ hybrid. The other is probably a back-cross with T. linifolia and bears a superficial resemblance to T. linifolia subsp. pallida,

since its leaflets are rather wide for subsp. linifolia; however, the leaves are exstipulate, subsessile, and the inflorescences tend to be indeterminate, which is not the case in subsp. pallida.

ii) A second probably hybrid situation is found on La Palma (Canary Islands): a specimen collected above Tenerra (13. VI. 1913, Sprague and Hutchinson 466, K) appears to be intermediate between T. linifolia subsp. pallida and T. stenopetala. Unfortunately the specimen is not in flower. Like T. stenopetala, it has triangular stipules, but it also has leaflets which are too long for this species (55 mm.) and the petiole is short (14 mm.) relative to the leaflet size: in the last characters it is more similar to T. linifolia subsp. pallida. In this context, it is interesting that T. linifolia subsp. gomeræ demonstrates more affinity with T. stenopetala than do any of the other subspecies: the single specimen has a racemose inflorescence (30 mm.), petiole 5.5-6.5 mm., and short stipules (2 mm.), whereas in subsp. pallida, which appears to be the most closely related subspecies, the raceme is condensed to a head, the petiole is short (1-3 mm.) and the stipules are relatively long (2.3-6 mm.).

9. T. osmariensis (Coss.) G. & D., comb. nov. ined.

Syn. Genista osmariensis Coss., Bull. Soc. Bot. de Fr., 20: 245 (1873).

Cytisus hosmariensis (Coss.) Ball, Jour. Linn. Soc. London (Bot.), 16: 404 (1878).

Cytisus webbianus Webb, non ed., (1837).

Tall shrub, branches patent-pubescent, ferruginous, slender. Leaves trifoliolate, petioles 6.5 mm.; leaflets 17 x 13 mm., broadly obovate, apex obtuse or slightly retuse, mucronulate; leaflets sparsely patent-pubescent above, more densely so below; petiolules 1.5 mm.; stipules 2.0 mm., linear-lanceolate. Inflorescence 16 mm., \pm determinate, flowers 7-9 in a short sub-corymbose raceme. Bracts subtending the flowers simple, ovate, caducous; pedicels 4.0 mm.; bracteoles (2) 4.5 mm., ovate, borne at the base of the calyx, caducous. Calyx 9-11 mm., patent-pubescent, the upper teeth acute, the lower teeth long, distinct, triangular. Standard 16 mm., emarginate, broadly ovate, with two small lateral projections at the base of the lamina, densely sericeo-pubescent on the outer surface. Keel \pm uniformly sericeo-pubescent. Legume not known. Fl. April.

Ecology: not known.

Distribution: Morocco, Tetuan. Only known from the type locality (map 12).

Type: Tetuan, Monte Beni Hosmar, 1827, Webb (isotype, K).

Icon: fig. 27.

MOROCCO

Tetuan, Monte Beni Hosmar, 12. IV. 1871, Ball (K).

Obs. The isotype specimen at Kew has a fragment collected by Ball from the type locality mounted on the same sheet. These specimens represent the only material of T. osmariensis which has been seen.

Although the specimen collected by Ball is not in flower, there are flower buds which have the same large ovate bracts and bracteoles as the type, but the Ball specimen differs from the latter in other respects:

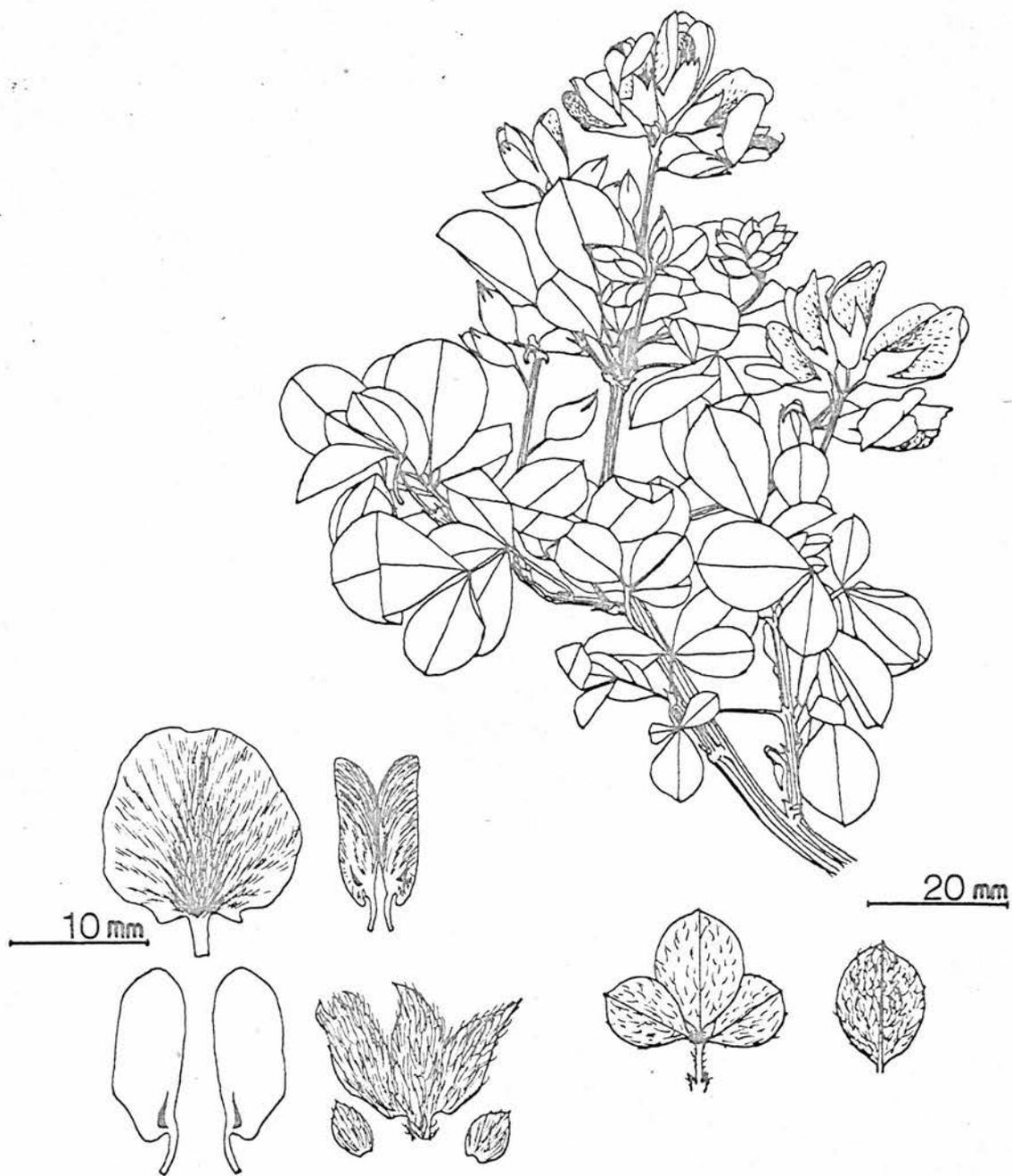
leaflets 21 x 10 mm., narrowly obovate, shortly adpressed-sericeous on both surfaces, more densely so below; stipules 3.0 mm., linear.

T. osmariensis is a distinctive species which appears to show closest affinities to T. monspessulana or T. linifolia. The shape of the bracts, bracteoles and standard petal, however, place this species on its own.

Fig. 27 (overleaf): T. osmariensis (source material: Morocco, Tetuan, Monte Beni Hosmar, 1827, Webb. K)

Map 12: Distribution of T. osmariensis

FIG. 27





MAP 12

SPECIES OF UNCERTAIN STATUS

Cytisus osyrioides¹ Svent.

Cytisus benehoavensis² (Bolle) Svent.

No specimens of these species have been seen.

¹ Bol. Inst. Nac. Invest. Agron. (Madrid) 20: 197-209 (1949).

² Bol. Inst. Nac. Invest. Agron. (Madrid) 30: 83-94 (1954).

APPENDIX

METHODS1) Anatomical Studies

- i) Leafy shoots taken from herbarium specimens were heated in water to 60°C and kept at this temperature for 30 minutes. They were then fixed and preserved in formalin-acetic-alcohol to which glycerol had been added to minimise hardening of tissues.
- ii) Short lengths of stem, each containing a node, were dehydrated in tertiary butyl alcohol (Johansen, 1940), embedded in paraffin wax (m.p. 55°C) and sectioned at 14-17 μ using a Reichert rotating microtome. In all cases it was found that the dehydrating and embedding processes had hardened the tissues to such an extent that poor sectioning ensued. To soften the tissues the trimmed blocks were soaked for 4-10 days in water to which a few drops of detergent had been added as a wetting agent. Sections were stained in safranin and fast green (Gurr, 1952) and permanent slides were mounted in Canada Balsam.
- iii) In addition to the preparation of serial sections through the nodal region, hand sections and dissections were made on all species. Fixed material was stained with phloroglucinol and hydrochloric acid after sectioning. Although this is only a temporary stain it was found to give clearer results than safranin and fast green, since as well as staining the xylem it bleaches the other tissues.
- iv) Drawings of transverse sections were made with the aid of a Gillet and Sibbert projection microscope.

2) Analysis of trihybrid specimens

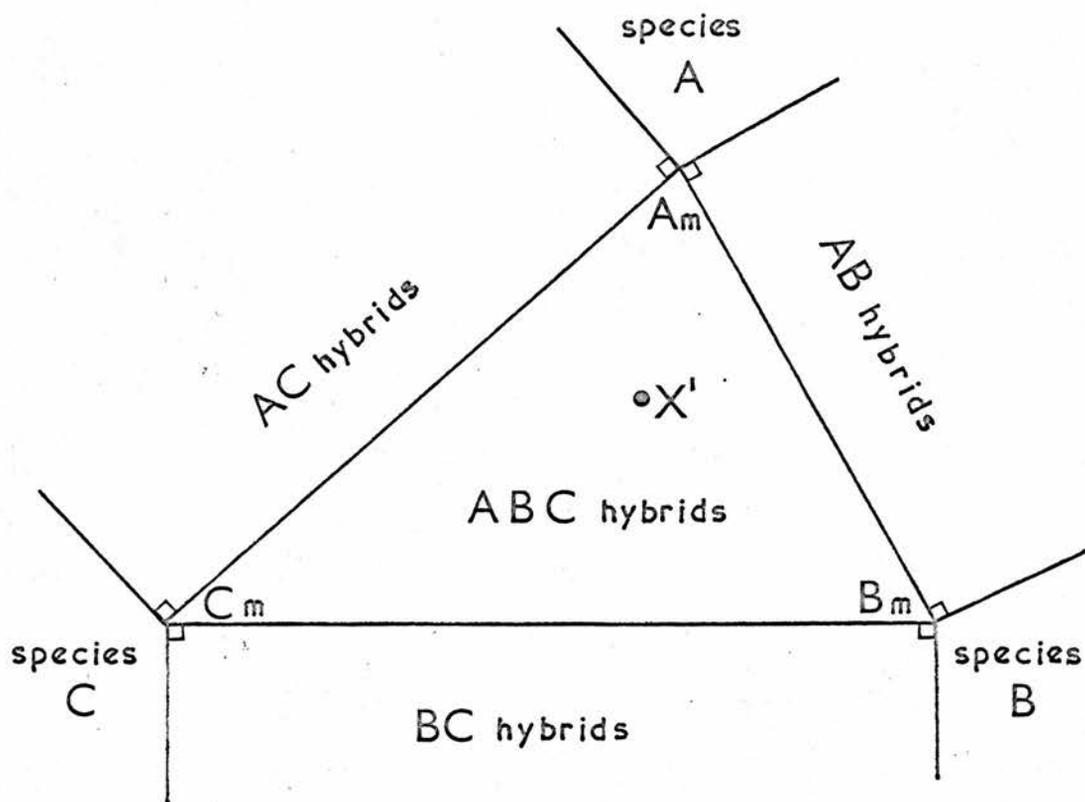
i) Linear criteria (ie., single characters) were found to be of no use in analysing hybrid populations in which trihybrids, dihybrids and pure specimens occur, since with three species, one is inevitably intermediate in any single character and will not be differentiated from the dihybrid of the two extreme species. For this reason it was necessary to add a second dimension, which was achieved by using characters in pairs as scatter diagrams, rather than single characters.

ii) The scatter diagrams were plotted by computer, using a programme devised by Mr R. Campbell. The position of each specimen and of the mean for each species (A,B,C) was plotted on 19 diagrams which were combinations of 14 characters; the specimens and means were numbered throughout.

iii) Each scatter diagram was then divided into areas, as in fig. 28: the species means (A_m, B_m, C_m) were joined together to form a triangle. Specimens inside this area were considered to be trihybrid, and outside the area to be dihybrid or pure. Perpendiculars to A_mB_m , A_mC_m and B_mC_m , at each of the means concerned, denote the boundary between dihybrid and pure specimens. Thus,

inside $A_mB_mC_m$	trihybrid (ABC)
outside $A_mB_mC_m$, between A_m & B_m	dihybrid (AB)
outside $A_mB_mC_m$, between A_m & C_m	dihybrid (AC)
outside $A_mB_mC_m$, between B_m & C_m	dihybrid (BC)

FIG. 28



d = distance

R = reciprocal

m = mean

A, B, C = species

X = specimen

$S = RdX_{Am} + RdX_{Bm} + RdX_{Cm}$

$$\%A = RdX_{Am} \times 100/S$$

$$\%B = RdX_{Bm} \times 100/S$$

$$\%C = RdX_{Cm} \times 100/S$$

eg. for specimen X',

$$dX_{Am} = 3 \quad RdX_{Am} = 0.33 \quad \%A = 0.33/0.67 = 50$$

$$dX_{Bm} = 5 \quad RdX_{Bm} = 0.20 \quad \%B = 0.20/0.67 = 30$$

$$dX_{Cm} = 7 \quad RdX_{Cm} = 0.14 \quad \%C = 0.14/0.67 = 20$$

outside AmBmCm, behind Am with respect to B & C	pure A
outside AmBmCm, behind Bm with respect to A & C	pure B
outside AmBmCm, behind Cm with respect to A & B	pure C

iv) Rough proportions could be drawn up for each specimen by inspection of the 19 diagrams in this way. (This step is analogous to the Anderson Hybrid Index technique since here too a measurable character range is divided into a number of regions, the proportions of the parental species assigned to the specimen depending upon the region in which it falls for this character.)

v) The results were quantified as follows:

a) The distance of the specimen to the means of the species concerned were measured (this step is unnecessary for specimens falling behind Am, Bm or Cm with respect to the other species, since the specimens can be assumed to be 100% pure for this character).

b) The percentage of each parental species was then calculated by the method formulated in fig. 28, the distance of a hybrid to a species mean being inversely proportional to the percentage of that species present in the hybrid. The calculation of percentages and the averaging of these results from the 19 diagrams, for each specimen, was carried out by a relatively simple computer programme.

c) The averaged compositions were then plotted on a triangular graph of which the apices were the species means. This triangular scatter diagram summarises the 19 diagrams and

demonstrates (1) the position of hybrid specimens with regard to the limits of specimens of the pure species (2) any trends in a hybrid population.

vi) Objections to this procedure:

a) From a statistical point of view, a considerable improvement would have been achieved if the inner limit of each species (with respect to the other two) had been used, rather than the species mean. However, this was impracticable since the inner limit falls on a different point not only with respect to each of the other species, but also with respect to each single hybrid. Since fairly good diagnostic characters were used it is hoped that the error introduced by using the species mean is minimal.

b) For results to be at all meaningful, the distances AB, AC and BC should be approximately equal, if not in each diagram, then at least as a total for all the diagrams. Two species which are consistently closer together will result in over-emphasis of one or other species, eg., a specimen of species A, where AB is far less than AC or BC, will show an appreciable percentage of species B whether or not the B genome is present. Unfortunately natural species are not usually equidistant in character from one another. This error was therefore reduced by choosing scatter diagrams in which the average distances AB, AC and BC were approximately equal.

c) There may be considerable bias involved in choosing pairs

of characters: an error may be introduced by using one character as a member of several pairs if this character is peculiar in any way for any specimen (eg., an extreme recombination). This aspect was unfortunately overlooked when the study was made.

d) It must be stressed that this method, like the Anderson technique, measures phenotypic character only and cannot really show the true genetic situation. Hybridisation studies alone can show whether these methods are efficient.

vii) Results from this procedure tallied well with those obtained by the Anderson technique for the dihybrids, or in the case of trihybrids, with the general appearance of the plants. Of 72 specimens, including 5 pure specimens of each species, 65 appeared correct, 5 correct within broader limits, and only 2 (both trihybrid) incorrect. The latter may be due to the bias mentioned in vi(c). This method appears to give better results than the computing techniques, with the exception of Modal Analysis, which were used on the same data. In addition, the method gives an estimate of the composition of each individual whereas the computing methods merely place it in a group of similar specimens. Establishing the composition of an individual could be of use in the horticultural trade either for nomenclatural purposes or in the synthesis of an advantageous natural cross.

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TK495.T405

CHARACTER 8

X

120 mm.

75

Inflorescence (X axis) and
Bracteole length (Y axis).

55

73

77

74

71

53

70

69

54

63

56

108

58

58

76

99

57

112

68

65

87

101

96

60

110

81

82

106

104

8

111

64

102

86

93

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78

78

103

90

109

94

107

95

85

104

91

97

83

89

107

95

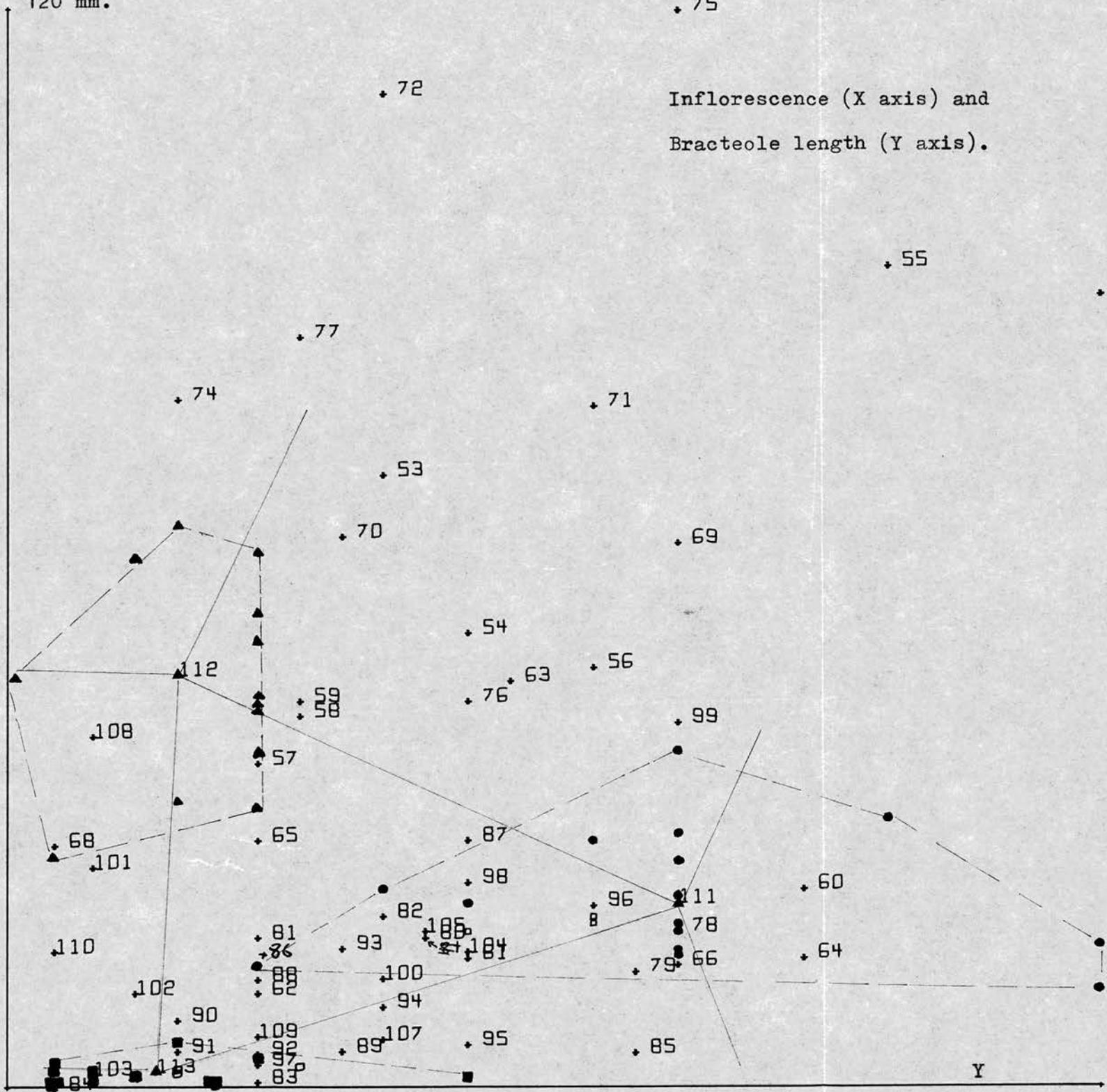
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Y

CHARACTER 6

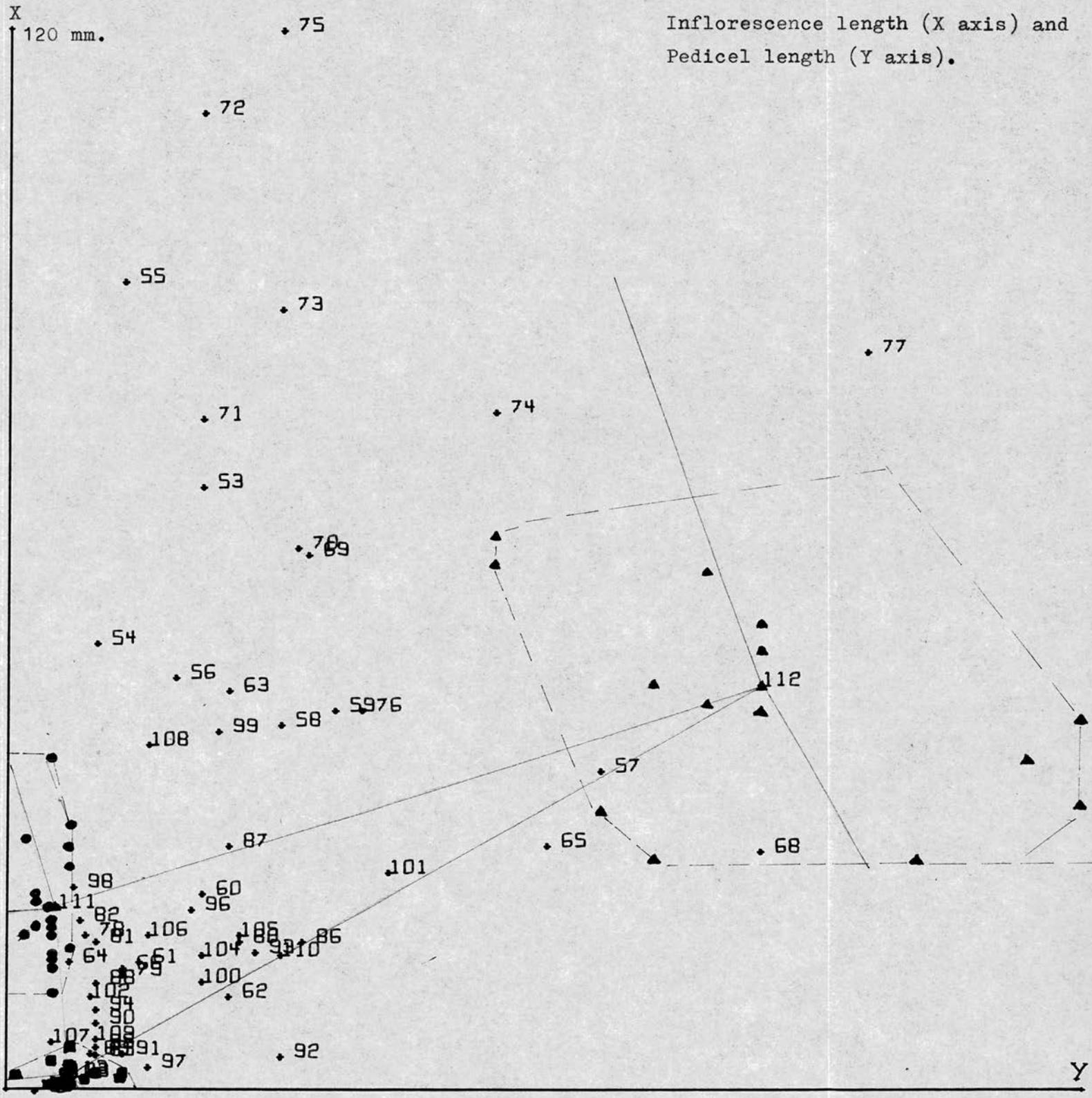
.4

3.0



CHARACTER 8

1.0

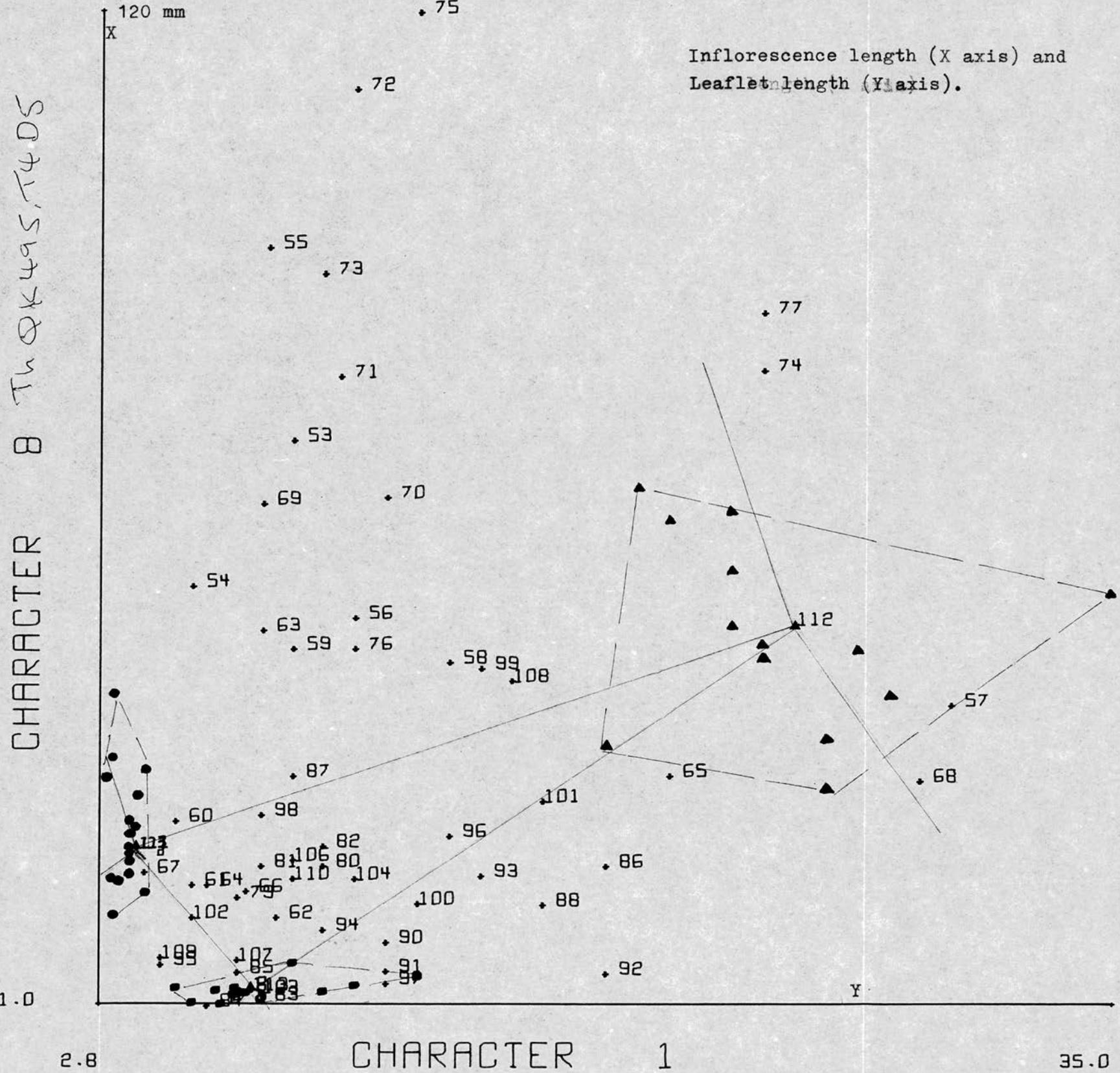


Inflorescence length (X axis) and Pedicel length (Y axis).

CHARACTER 4

21.0

CHARACTER 8 Th QK 495, T4 D5



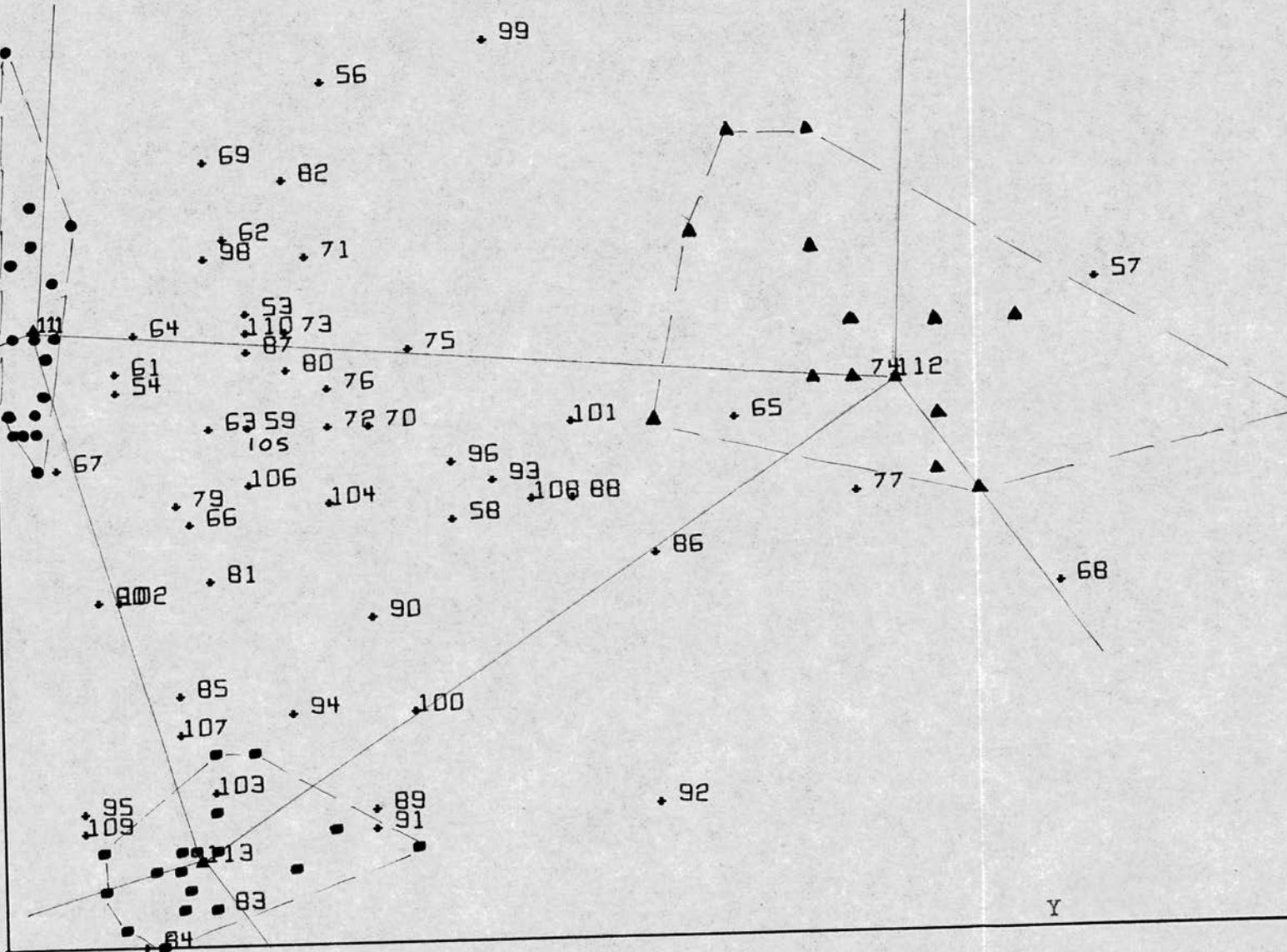
7.0 mm

X

.55

Floral interval (X axis) and
Leaflet length (Y axis).

CHARACTER 11



CHARACTER 1

7.0 mm

X

.55

Floral interval (X axis) and
Petiole length (Y axis).

CHARACTER 11
Th QK 49 S T 40 S

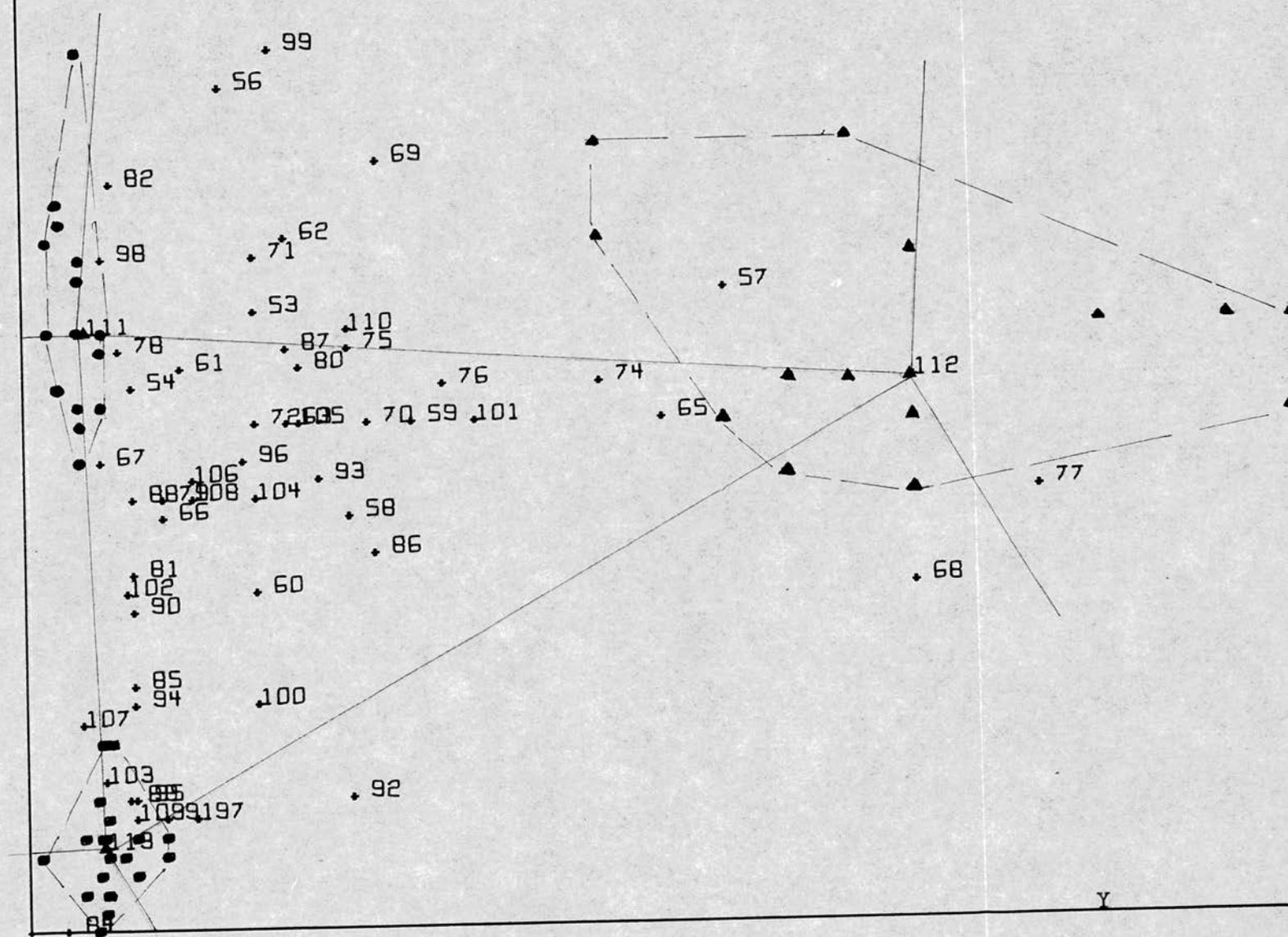
.3 mm

Y

8 mm

CHARACTER 4

21.



7.0 mm

X

.55

Floral interval (X axis) and
Leaflet length/width ratio (Y axis).

7th QK 495.T4D5

CHARACTER 11

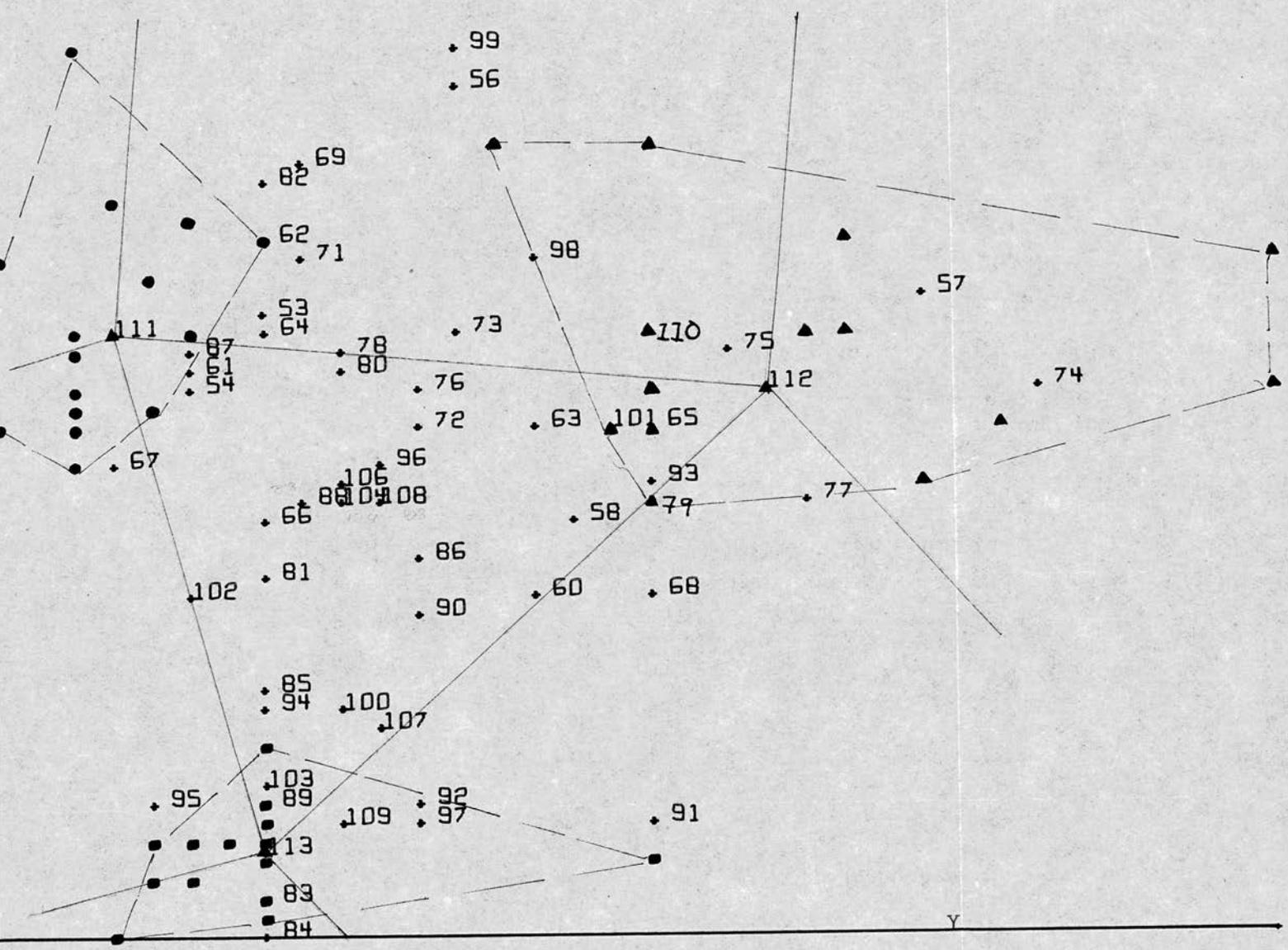
.3 mm

Y

1.3:1

CHARACTER 2

4.6:1



24.0:1

TK 495.T4D5

Leaflet/stipule length ratio
(X axis) and floral interval
(Y axis).

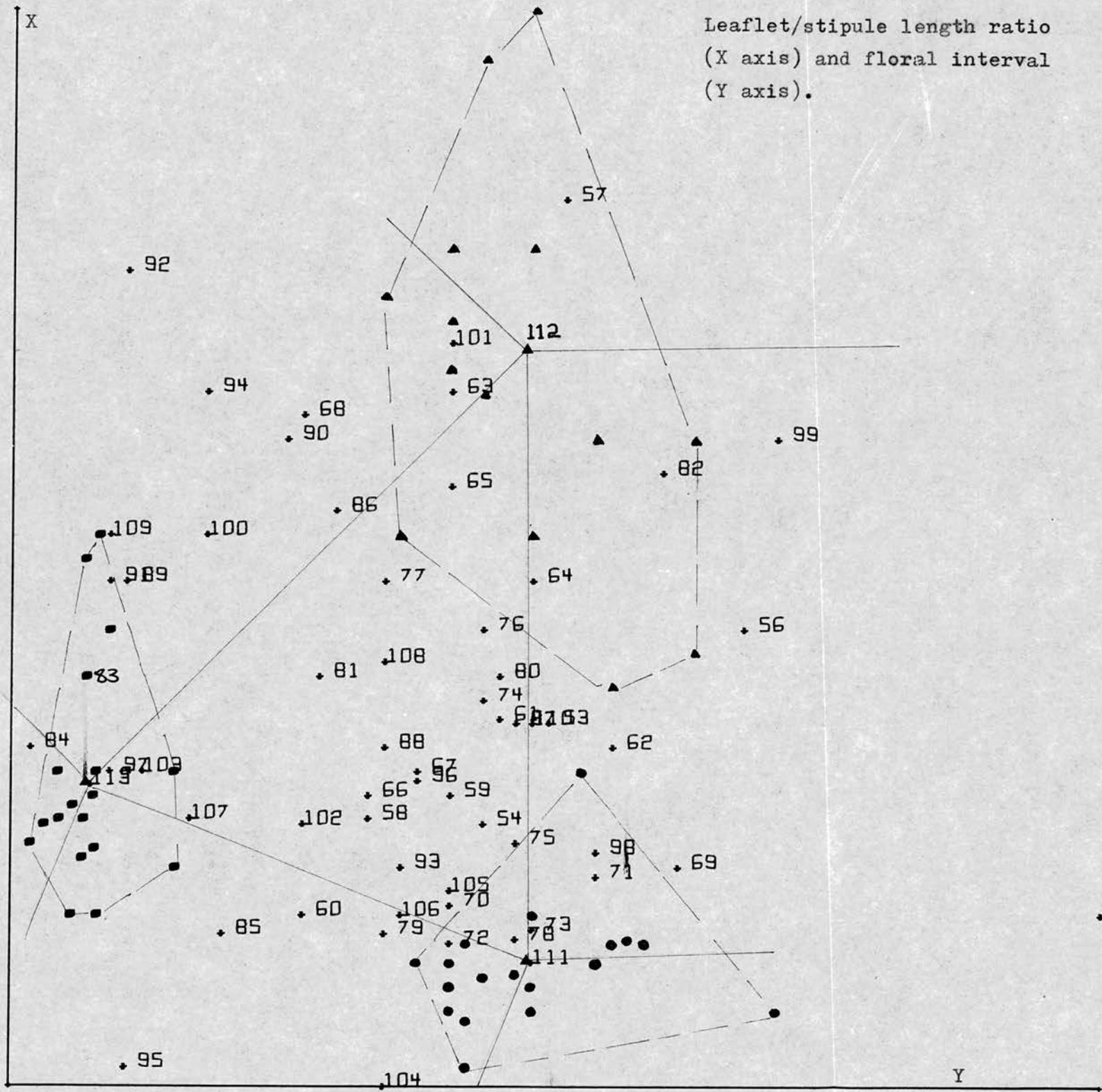
CHARACTER 12

1.4:1

.3 mm.

CHARACTER 11

7.0 mm.



16.0 mm

X

.74

Corolla length (X axis) and
Floral interval (Y axis).

Th
QK495.T4D5

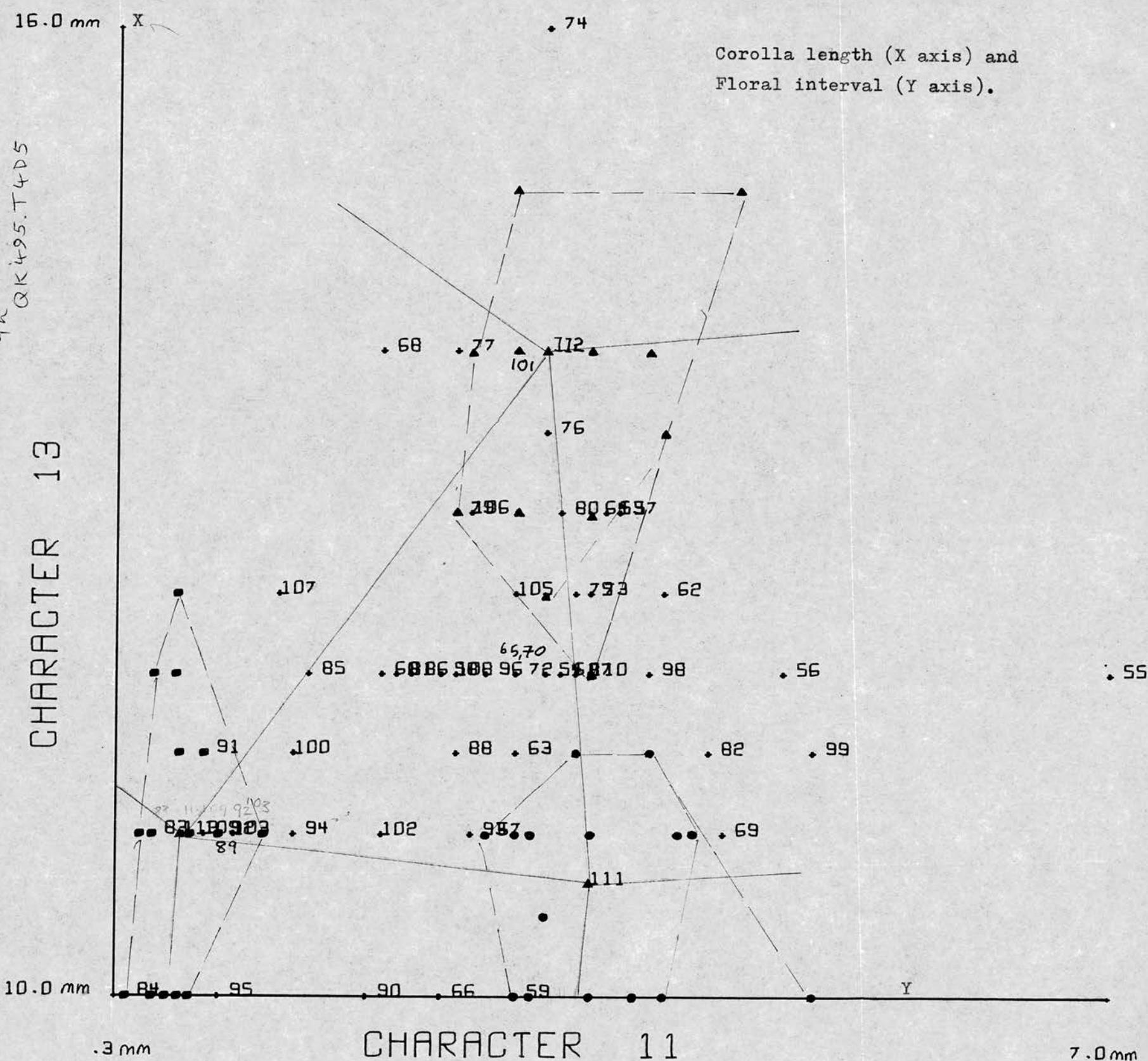
CHARACTER 13

10.0 mm

.3 mm

CHARACTER 11

7.0 mm



24.0:1

Th QK495.T4D5

Leaflet length/floral interval ratio
(X axis) and no. of flowers per
raceme (Y axis).

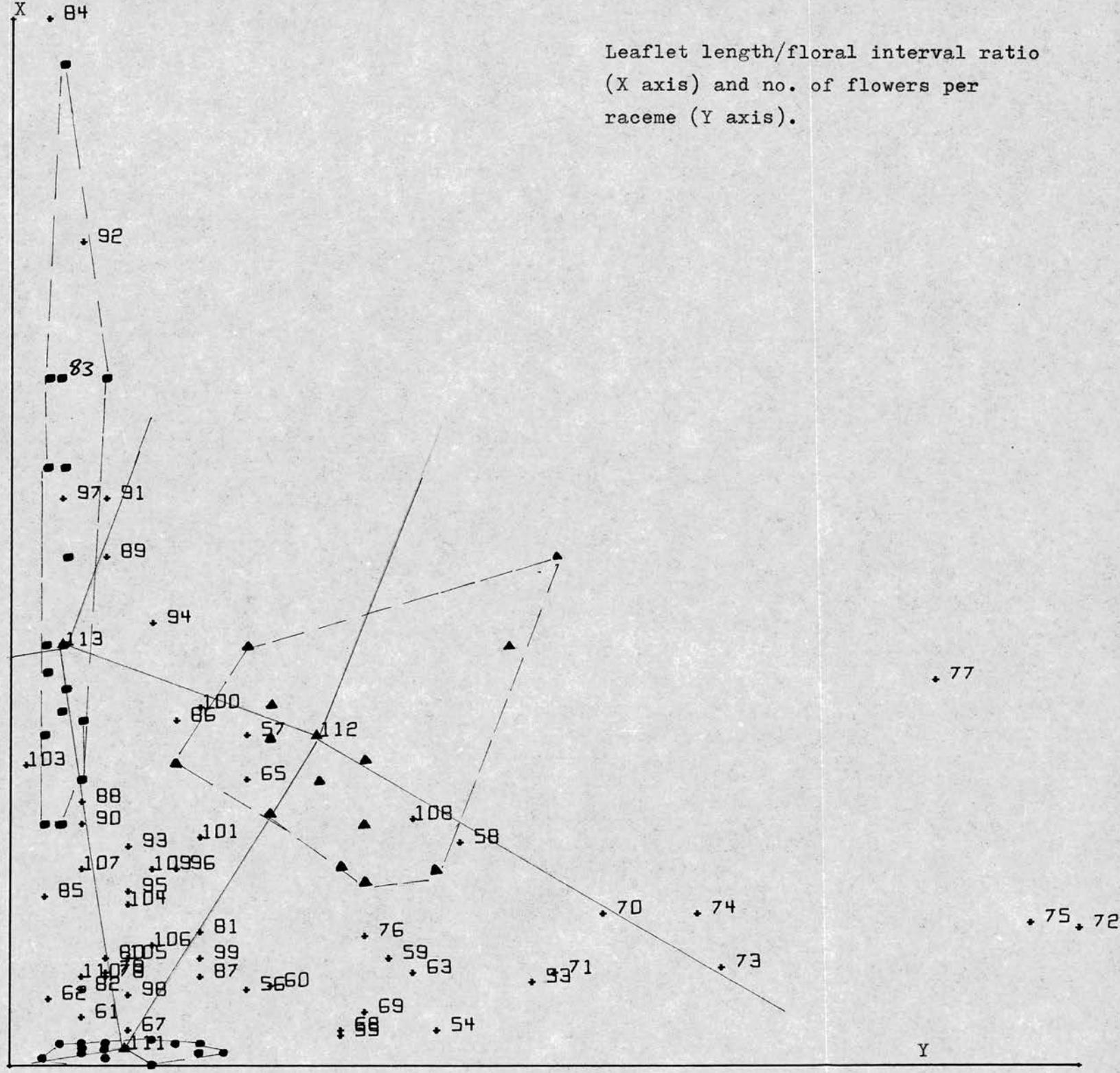
CHARACTER 15

.6:1

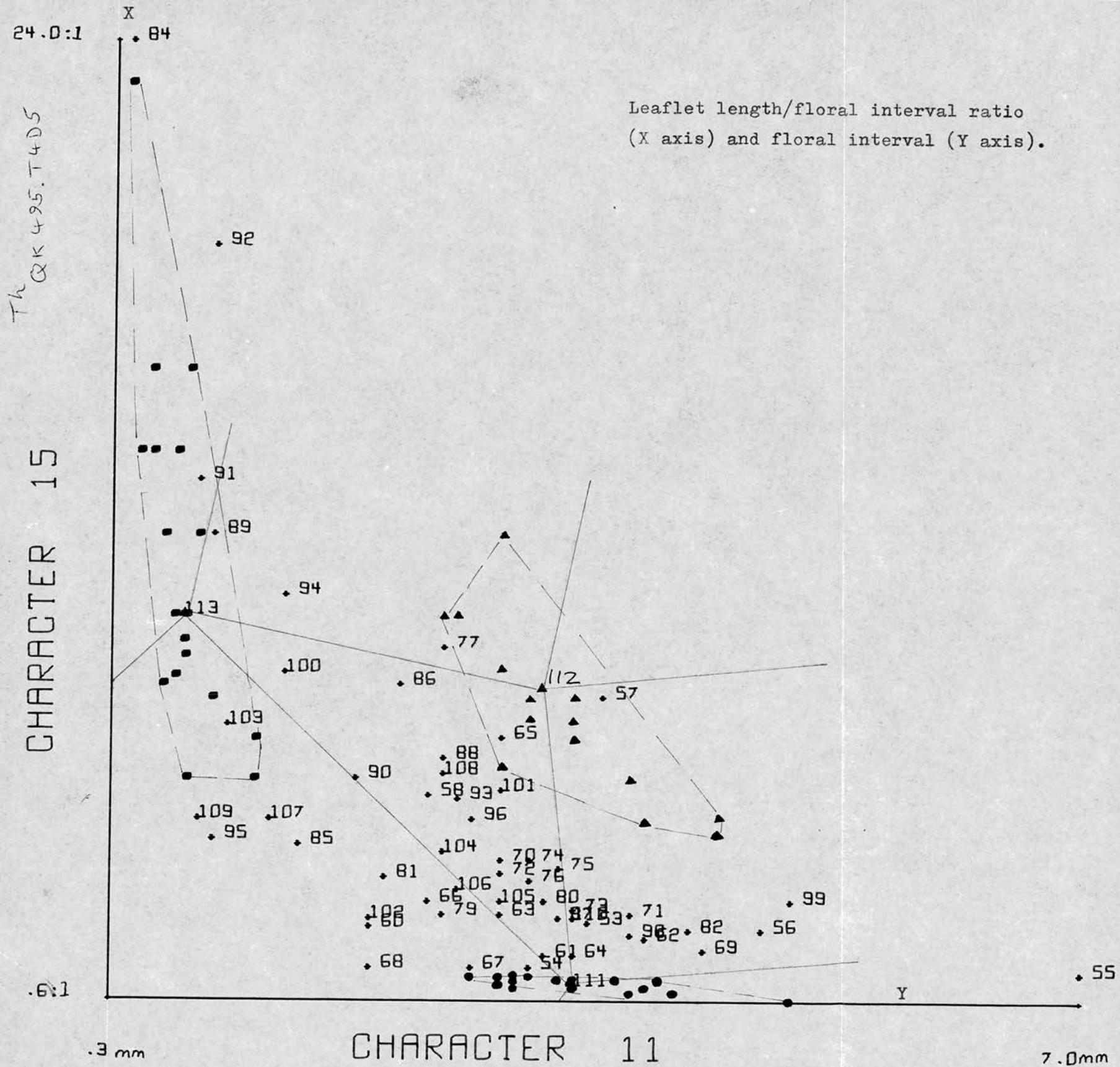
3.0

CHARACTER 10

48.0



Y

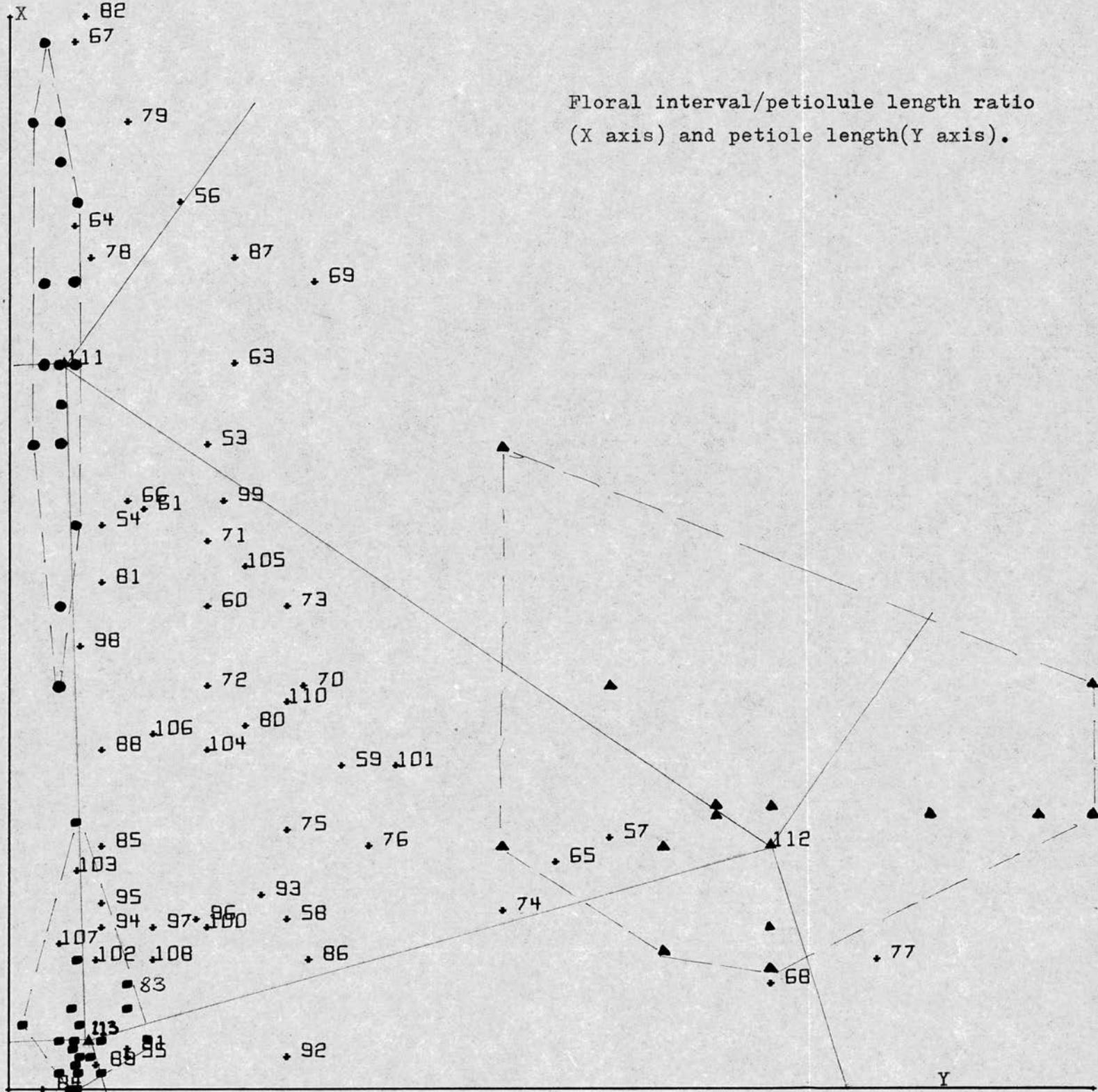


14.3:1

X

Floral interval/petiolute length ratio
(X axis) and petiole length(Y axis).

CHARACTER 16 T Q K 4 9 5 T 4 D 5



1.0:1

Y

.8 mm

CHARACTER 4

21.0

14.3:1

X

. 82

. 67

Floral interval/petiolute length ratio
(X axis) and leaflet length (Y axis).

. 79

. 56

. 64

. 87

. 69

111

. 682

. 53

CHARACTER 16

. 61

. 66

. 99

. 54

. 71

. 81

105

. 73

. 60

. 98

. 110 . 72 70

. 106 80

. 59

. 104

. 88

. 101

. 85

. 76

. 75

. 103

. 95

. 107

. 94

. 97

. 100

. 93

. 109

. 102

. 107

. 94

. 97

. 100

. 96

. 108

. 86

. 74

. 77

112

. 57

. 68

1.0:1

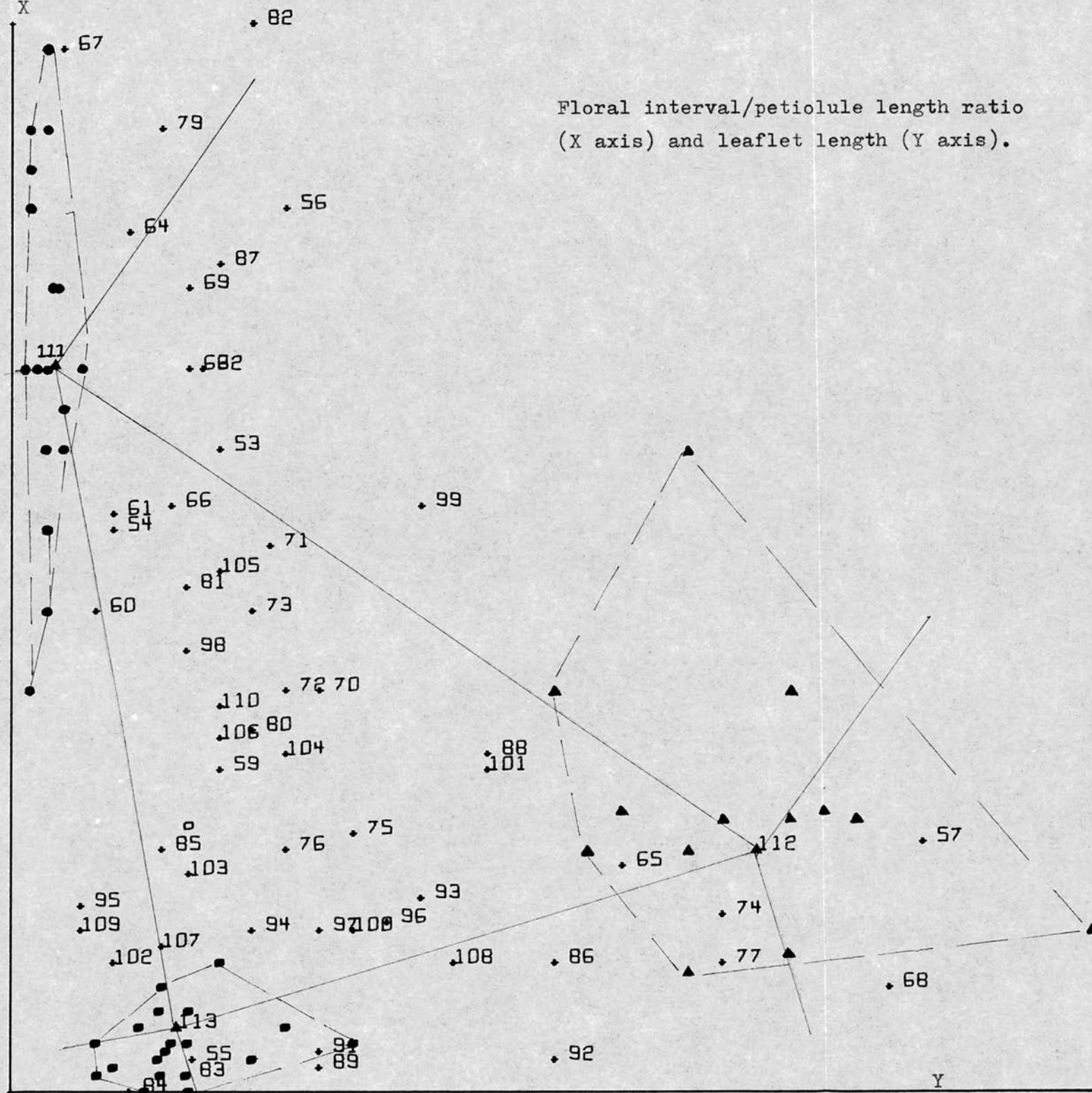
Y

2.8 mm

CHARACTER 1

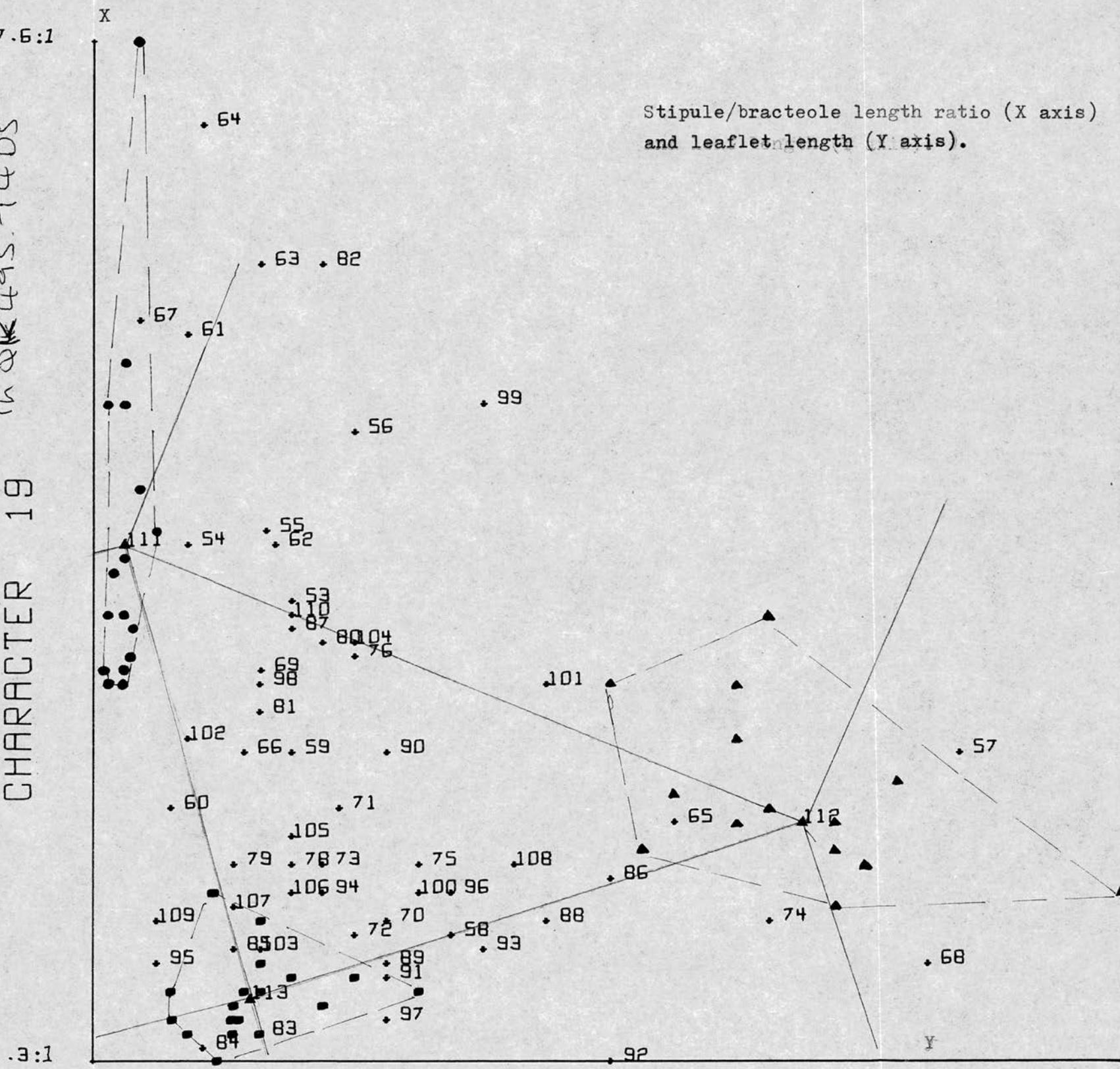
35.0

The QK 495. T405



CHARACTER 19
Tn QK 495. T405

Stipule/bracteole length ratio (X axis)
and leaflet length (Y axis).



2.8 mm.

CHARACTER 1

35.0 mm.

7.6:1

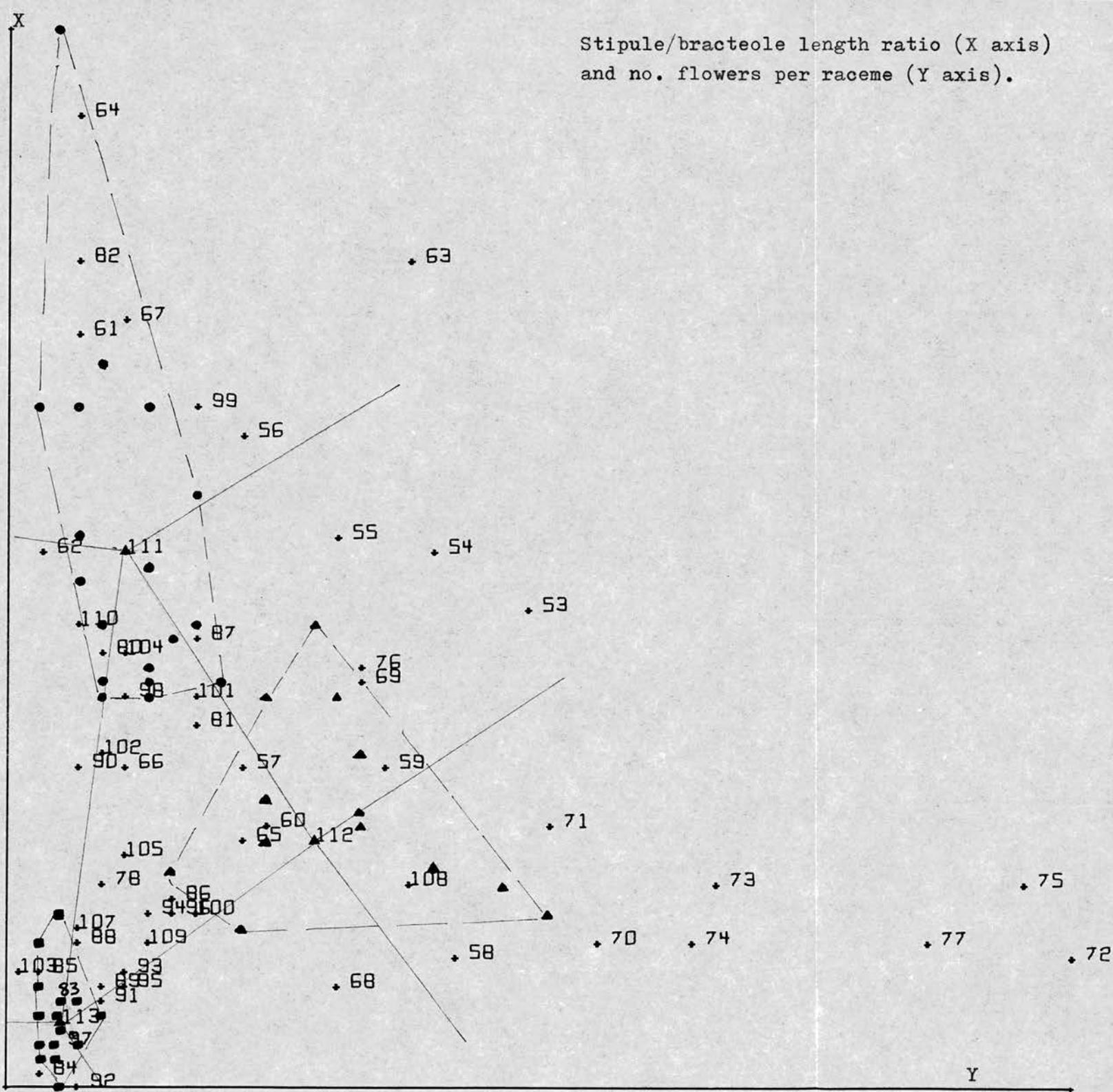
CHARACTER 19
TK495 T4DSStipule/bracteole length ratio (X axis)
and no. flowers per raceme (Y axis).

.3:1

3.0

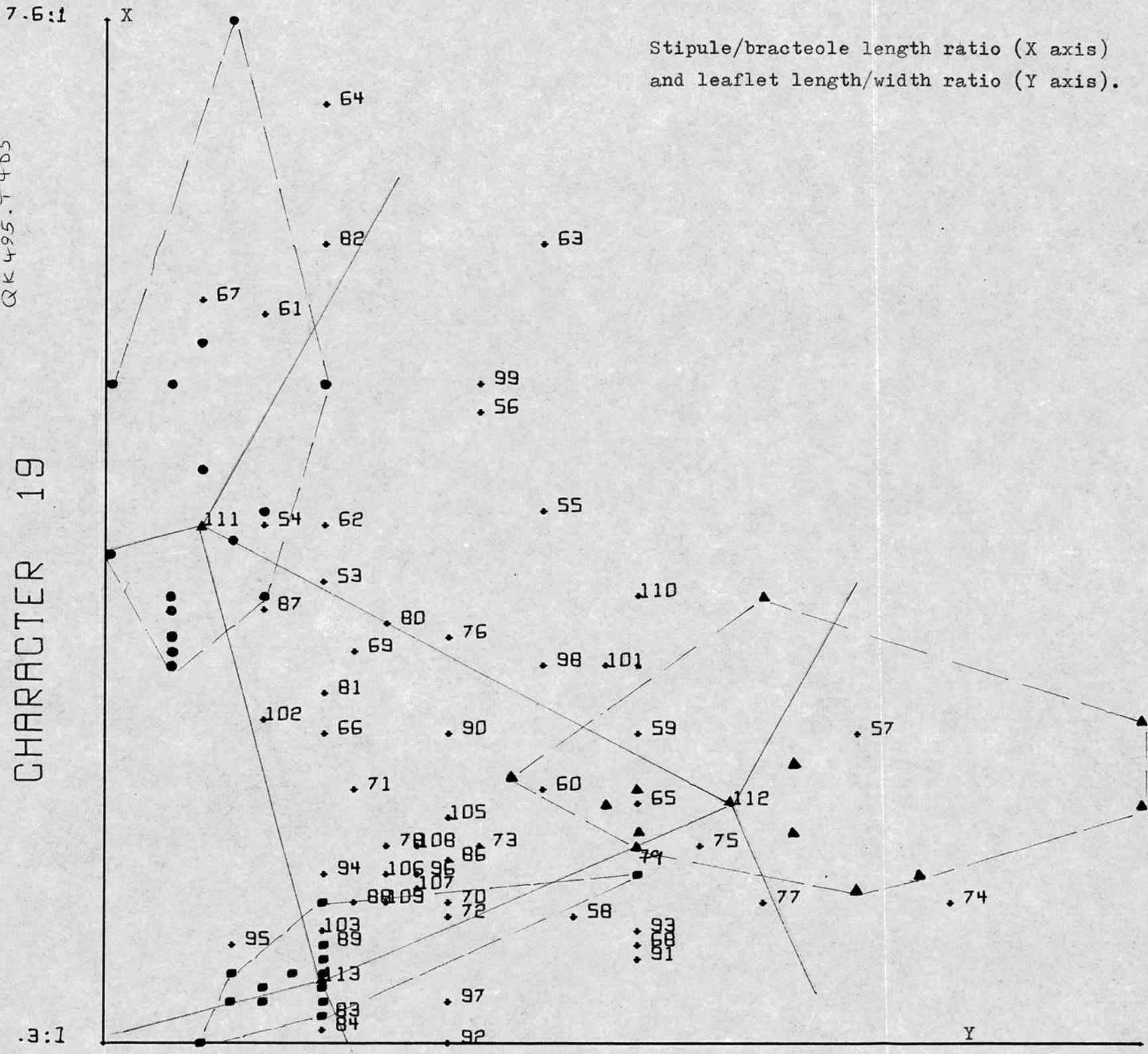
CHARACTER 10

48.0



TK QK 495.T 405

Stipule/bracteole length ratio (X axis)
and leaflet length/width ratio (Y axis).



CHARACTER 19

CHARACTER 2

7.6:1

.3:1

1.3:1

4.6:1

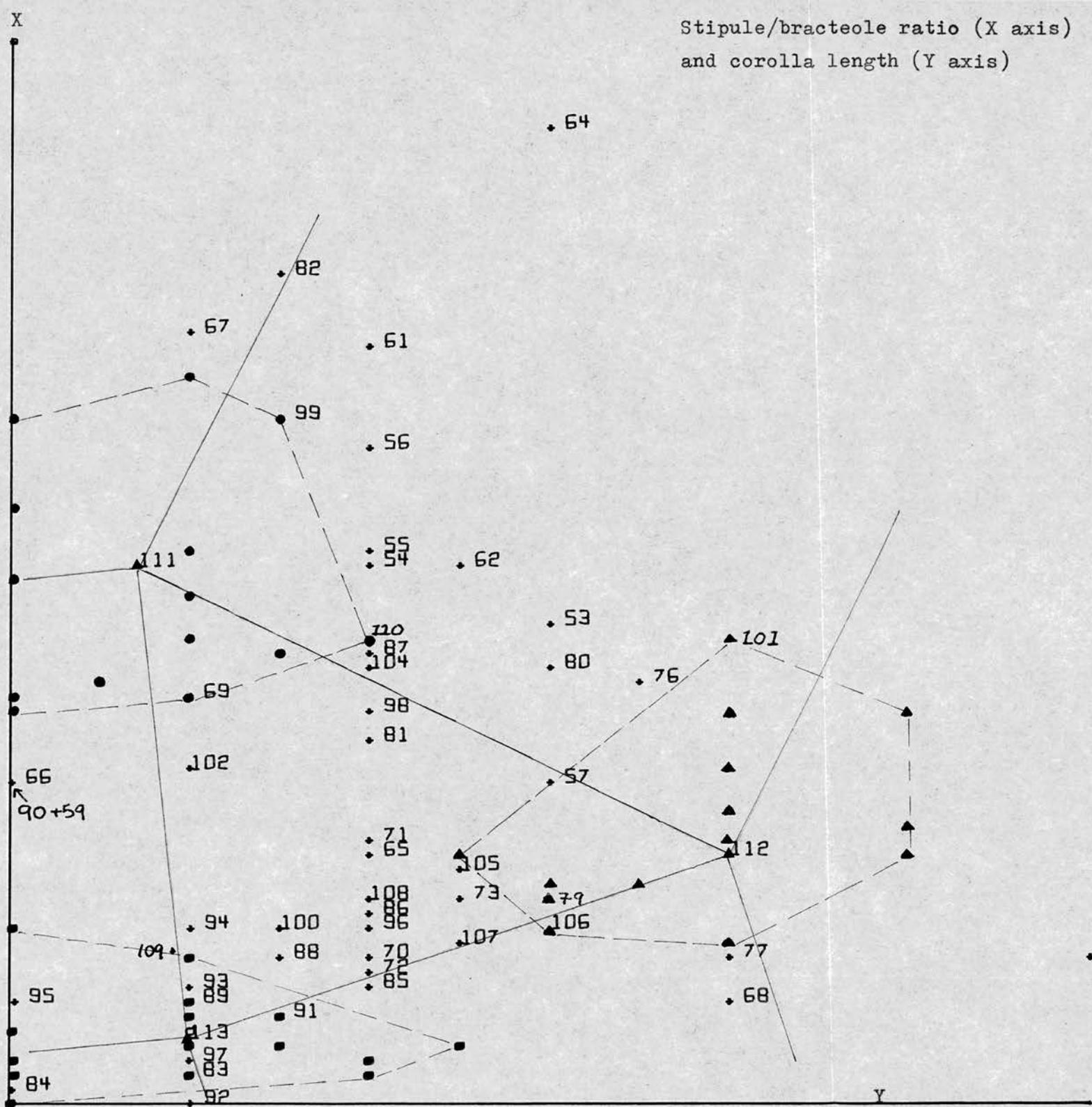
7.6:1

Stipule/bracteole ratio (X axis)
and corolla length (Y axis)

TK QK 495.T4D5

CHARACTER 19

.3:1



10.0 mm

CHARACTER 13

16.0 mm