

## MATERIALS FOR A FLORA OF TURKEY: VIII CRUCIFERAE I: ISATIS

P. H. DAVIS

*Department of Botany (University of Edinburgh)*

### INTRODUCTION

THE genus *Isatis* L. is one of the most intractable Cruciferous genera in the Near East. The species are so exceptionally variable that it is very difficult to know where to draw the line between them; even the fruit—usually a rather constant feature in the Cruciferae—is no less variable than the vegetative parts which in this genus do not provide as many differential characters. The paucity (or unreliability) of vegetative and floral characters (excluding those of the fruit) means that it is difficult or impossible to identify many specimens in the absence of mature fruits.

Previous accounts which have been most helpful for the revision of the Turkish species are those by Boissier (*Flora Orientalis* 1: 376, 1867), Bornmüller (*Feddes Rep. Beih.* 89 (1): 75-82, 1936) and the recent, painstaking revision of the Caucasian species by Avetisian (*Not. Syst. Geogr. Inst. Bot. Tbil.* fasc. 23: 72-86, 1963). Opinion on the delimiting of *Isatis* species has varied greatly, Avetisian's treatment being more conservative than that given by Busch (*Fl. U.R.S.S.* 7: 203-222, 1939) and Grossheim (*Fl. Kavkaza*, ed. 2, 4: 122-130, 1950); mine is somewhat more conservative than Avetisian's, largely due to the recognition of subspecies. It should be said at once, however, that the account to be published in the *Flora* can only be considered as provisional, and will almost certainly need to be modified when additional, well-collected material becomes available. This situation, of course, obtains in many Middle East genera, but the problem is particularly acute in *Isatis*, a genus in which intermediates have been collected between several taxa which are usually treated as well distinguished species.

The author has had the opportunity of studying material not only in the British herbaria, but in Leningrad, Paris, Geneva and Tbilisi; he is indebted to Dr. K. H. Rechinger for the loan of *Isatis* material from the Vienna Museum and to Dr. A. Huber-Morath (Basel) for allowing him to work over his splendid Turkish collection. Not only has the study of these collections enabled the taxonomy of the group to be more firmly based; examination of type material has enabled several names, hitherto wrongly applied or of uncertain application, to be used with certainty. The opportunity to correlate the taxonomy of the Anatolian species with those from Caucasia has proved invaluable.

Like many genera in the Cruciferae, *Isatis* has been very poorly illustrated, in the majority of cases only the fruit having been drawn. Even such a distinctive and widespread species as *I. lusitanica* L. (*I. aleppica* Scop.) has no good illustration.

## CHARACTERS AND THEIR VARIATION

Some notes are given here on the taxonomic characters readily available and the variation which they show.

Duration and habit. Boissier divided Section *Glastum* (i.e. Sect. *Isatis*) into perennial, biennial and annual groups of species. Although some species (particularly high mountain ones) are strongly and unambiguously perennial (*I. frigida*, *I. takhtajanii*), with numerous sterile shoots at flowering time, in others the distinction between biennial and short-lived perennial is not clear-cut (*I. tinctoria*, *I. candolleana* (*I. conringiifolia*) and *I. pinnatiloba*). Whether this variation is a direct environmental response, or the result of inherited differences, is not known. *I. lusitanica* (*I. aleppica*) is invariably annual (the only therophyte usually included in Sect. *Isatis*), and *I. callifera* and *I. cochlearis* appear to be constantly biennial. In some species of Sect. *Aptero-lobus* (a section described as annual by Boissier), *I. buschiana* and *I. iberica* may be either annual or biennial—from herbarium material it is often impossible to decide which. It would be a great help if collectors would make field notes on the duration of the plant, in the case of biennials looking for plants existing as sterile rosettes in their first year. A few taxa are especially woody at the base (e.g. *I. cappadocia* subsp. *alysifolia*).

Leaves. Basal (radical) leaves and median stem leaves are always very different in form, so that both should be collected. To do so can be difficult, because in many species the former have withered by the time the plant is in fruit. In many species the basal leaves vary from entire to toothed (*I. tinctoria*, *I. aucheri*), whereas in others they are always entire (*I. glauca*, *I. sivasica*); in *I. lockmanniana*, *I. pinnatiloba* and *I. lusitanica* they are pinnately lobed. The transition from petiolate basal leaves to sessile cauline leaves may be gradual or abrupt, and does not provide a constant character for species recognition.

Presence or absence of auricles on the median stem leaves has been used for distinguishing species, but a certain amount of variation must be allowed for—in *I. glauca* for instance, the auricles may be absent or short; furthermore, this character cuts across affinities suggested by the form of the fruit. On the whole, however, species may be artificially divided into those with prominent auricles, and those in which the auricles are short or obsolete; this distinction is difficult to express quantitatively, due to differences in leaf size and shape, and differences related to the position of the leaf on the stem. The shape of the auricles has been used a great deal for species separation—whether acute (*I. tinctoria*) or obtuse (*I. arenaria*, *I. spectabilis*), but the character often varies from one plant to another (as in *I. cappadocia* subsp. *subradiata*). *I. gaubeana* and *I. candolleana* are remarkable for their large, clasping, rounded auricles; those of *I. cochlearis* and *I. callifera* are only slightly less conspicuous, due to the more elongated lamina.

Apart from the character of the auricles, the general shape of the cauline leaves can be diagnostic; they are exceptionally short and broad in *I. candolleana* and *I. gaubeana*, and in *I. kotschyana* usually more elongated than in *I. glauca*. Many species, however, show great variation in the length/breadth ratio of their stem leaves. The shape of the leaf apex varies from species to species and is sometimes helpful for identification (blunter in *I. arenaria* than in *I. tinctoria*, acuminate in *I. amani*), but many species are

very variable in this respect (*I. cappadocica* sensu lato); in all species the leaves become narrower and more pointed towards the upper part of the stem.

Leaf texture is certainly an important specific character—whether membranous (*I. tinctoria*, *I. callifera*), or leathery (*I. glauca*, *I. huber-morathii*); most species with thick leaves have the auricles short or absent. Leaf texture in dried material, however, is difficult to assess and shows some seasonal variation. In most species the leaves are more or less glaucous, but are exceptionally so in *I. candolleana* and *I. gaubeana*; in *I. glauca* they often dry a characteristic yellowish green. A few species have greenish leaves (*I. bitlisica*).

Leaf indumentum may be characteristic (e.g. the villosity of *I. aucheri* and *I. undulata*), but in many species we find variation from pubescent or even hirsute to glabrous leaves in the same population (as in *I. glauca*, *I. tinctoria*, *I. cappadocica* sensu lato). Furthermore, this variation in the indumentum of the leaves (and of the stems) is often *not* correlated with that found on the fruits, presumably due to being controlled by different genes.

Stem and inflorescence. In many species the stem is more or less terete (*I. tinctoria*, *I. buschiana*), in others sharply angular (*I. floribunda*, *I. spectabilis*); the distinction, however, is not always clear-cut. Stem height, thickness and indumentum vary in wide limits in some species (*I. glauca*), much less so in others (*I. aucheri*). The inflorescence can provide neglected characters, being in some species more corymbose or branched than in others. Though most species bear their racemes in a compound panicle, in a few Turkish taxa the inflorescence is less branched, as in *I. cappadocica* subsp. *cappadocica* which bears a short simple corymb of racemes. The vast, branched, pyramidal inflorescence of *I. spectabilis* is characteristic, but cannot be appreciated in herbarium material. Rarely the angle of branching is diagnostic, as in *I. floribunda* which differs from its allies in the narrow angle of its inflorescence branches, producing a dense, flat-topped corymb. The height at which the stem branches may be characteristic in some species.

Flowers. Unfortunately no striking floral characters could be detected. Flower size, however, may provide a differential character (as between *I. takhtajanii* and *I. kozlowskyi*), but considerable overlap is generally found. Some species appear to have broader petals than others (in *I. lusitanica*, for instance, they are usually narrower than in *I. tinctoria*), but so often a floral difference (including presence or absence of indumentum on the sepals), detected on limited material, breaks down when more is examined. Flowers are frequently galled.

Fruits. The indehiscent fruit of *Isatis* no doubt represents a highly specialised state in the Cruciferae, and has always been stressed as the most useful feature in the classification of the genus. Despite its considerable variability within many species, its importance both for classification and identification cannot be denied. But there are difficulties. It is often impossible to infer from immature fruit what the form of the ripe organ is going to be. Even the general outline of the fruit changes greatly as the fruit ripens; in many cases even the Sections cannot be recognised when the plants are in flower. In many species the thickness of the wing (used as a sectional character) changes during maturation from thin and membranous to thick

and spongy due to enlargement of parenchyma cells, and may finally become almost inflated (*I. buschiana*, *I. spectabilis*). The width of the wing, relative to the loculus, is often a useful diagnostic character, and provides an important sectional character; in Sect. *Apterolobus* the lateral wing is obsolete. The general form of the fruit (length/breadth ratio, where broadest, whether tapered or rounded at the ends, etc.) provides useful characters which vary much more in some species than others. In a few species the fruit is constantly and deeply emarginate (*I. aucheri*, *I. undulata*); in others emargination is inconstant (*I. frigida*, *I. cappadocica*). The venation of the wing in Sect. *Samerarioides* is apparently related to its manner of growth, strongly retrorse venation being most pronounced in fruits with a cordate base (e.g. *I. besseri*, probably best treated as a subsp. of *I. cappadocica*). The position of the loculus may be diagnostic; it is usually median, but in *I. lusitanica* and *I. constricta* it is situated well above the middle of the fruit, and in *I. cochlearis* well below it. In the latter species, and in *I. buschiana*, the fruit is somewhat inflated (instead of flattened) below the loculus. Any ornamentation on the loculus changes, and becomes accentuated, as the fruit ripens. The median rib becomes more prominent, and in some species becomes thickened (*I. candolleana*, *I. buschiana*, *I. cochlearis*) or winged on either side (*I. lockmanniana*, *I. callifera*).

In view of the exceptional variability of most of the available characters used in the taxonomy of *Isatis*, it is particularly necessary that as many characters as possible should be used for the identification of the species.

#### GEOGRAPHICAL DISTRIBUTION AND THE SPECIES PROBLEM

*Isatis*, and the closely allied annual genera *Sameraria* and *Pachypterygium*, are predominantly Irano-Turanian genera. *Isatis* shows its major development in an area extending from Anatolia to Central Asia, being richest in species in Anatolia, Transcaucasia, Iran and N. Iraq. Although the largest number of species grows in Anatolia, Iran is the only country in which all of Boissier's sections (together with *Sameraria* and *Pachypterygium*) occur. In Turkey Sect. *Samerarioides* contains 8 species (including 6 subspecies of *I. cappadocica*, several of which have often been previously treated as species), and Sect. *Isatis* 17 species (including several subspecies of *I. glauca* and *I. tinctoria*); Sect. *Apterolobus* is represented by the quite widespread but overlooked *I. buschiana*; Sect. *Eremoglastum* is absent. In fact, *I. cappadocica* (*I. latisiliqua* auct.), *I. tinctoria* and *I. glauca* are among the most polymorphic and widespread species of the genus, the last representing an Irano-Turanian counterpart of the predominantly more western, less xerophytic *I. tinctoria* whose complex is centred in Europe.

With 17 species and 3 subspecies of the 26 Turkish species (including 12 subspecies) endemic to Turkey, one is led to believe that Anatolia has been an important speciation centre in the evolution of Sections *Isatis* and *Samerarioides*. The great majority of the species found in Turkey belong to the Irano-Turanian element: *I. cappadocica* s.l., *I. erzurumica*, *I. bitlisica*, *I. sivasica*, *I. candolleana*, *I. aucheri*, *I. undulata*, *I. glauca*, *I. kotschyana*, *I. constricta*, *I. takhtajanii*, *I. kozlowskyi*, *I. floribunda*, *I. lockmanniana* (?), *I. cochlearis*, *I. spatella* and *I. buschiana*. *I. pinnatiloba* and *I. callifera* are confined to the Mediterranean region, and only *I. arenaria* to the Euro-

Siberian region (Euxine province); the latter, however, probably grows in an enclave of Mediterranean vegetation on sand-dunes. *I. amani* and *I. frigida* also occur within the Mediterranean region, but may grow in Irano-Turanian enclaves at high altitudes—to know that, one would need knowledge of the community in which they grow. The remaining species occur in both Irano-Turanian and Mediterranean territory: *I. tinctoria* (probably extending into the Euxine province) and *I. lusitanica*. Though present on the Greek mainland, the genus is absent from the Aegean islands and from Cyprus. Sect. *Samerarioides* has reached N.W. Africa where it is represented by one endemic species, *I. djurdjaedae* Coss. & Dur.

The general picture suggested by the distribution and relationships in *Isatis* is of a basically Irano-Turanian genus which has undergone its sectional differentiation in that region, then spread westwards into Europe and the Mediterranean area. The large number of vicarious species and subspecies suggest that geographical, or eco-geographical, isolation has been important in the differentiation of peripheral taxa.

Some species certainly grow together in Turkey and yet remain distinct; this is the case with two steppe species of Sect. *Isatis*, *I. glauca* and *I. floribunda*, in Inner Anatolia. On the other hand, taxa which are morphologically less similar than these often intergrade. No one, knowing only the extremes of variation which I have included in *I. cappadocica* sensu lato, would suggest that these plants were conspecific. Yet the weight of intermediate material, linking the series of taxa together in a variation chain, forces one to assign subspecific rank to what would otherwise be treated as distinct species. Such intergradation even cuts across sectional boundaries, as between *I. cochlearis* (Sect. *Isatis*) and *I. guestii* (Sect. *Apterolobus*).

Why this exceptional variation in a family renowned for the constancy of its fruit characters? Why the occurrence of intermediates between what would often otherwise be considered as morphologically well-marked species? Are these variable populations the flux from which aberrant peripheral populations (classified as species or subspecies) have been derived? Or have many of the taxa been better isolated in the past, geographically and morphologically, than they are today? Have these come in contact with each other as one or both of them extends its range in disturbed habitats, leading to hybridisation and/or introgression? Has this been followed by stabilisation and further differentiation? Whatever is the answer (and several processes may be operating), it is a fact that most species are plants of open habitats, where selection pressure is presumably low. Under present circumstances, with the habitat becoming increasingly disturbed by man, there may be selection for extreme variability, rather than uniformity. It may be that the fruit, as the unit of dispersal, is now most successful when most variable. Or does the fruit shape no longer have much selective advantage, so that its variation is poorly canalised by natural selection? These are problems which it is interesting to speculate on, but which our present state of knowledge does not enable us to answer.

Although much may be done to improve the classification of *Isatis* when more material of the rarer species becomes available, we cannot hope to understand the biological problems involved without biosystematic study. The first need is for adequate population samples (preferably in fruit) in order to find out how variable populations are. Collateral cultivation to test



the range of phenotypic plasticity, and breeding work to test the crossability of taxa, will be needed before one can establish the presence or absence of hybridisation and/or introgression. A few gatherings cultivated at Edinburgh (*I. glauca* subsp. *iconia*, *I. floribunda*, *I. lusitanica*) showed considerable differences in vegetative features from the wild material. All these plants have failed to set seed, suggesting that neither self-pollination nor apomixis was operating. The genus would be an excellent one for study by a resident botanist in the Near East.

#### SECTIONAL CLASSIFICATION

The sections of *Isatis* recognised by Boissier have persisted in use to the present day. They are primarily based on the width and texture of the fruit wing relative to the loculus. These sections are not very satisfactory for several reasons: 1) they are poorly delimited; 2) some species hover uneasily between them—e.g. *I. glauca* (*sensu lato*), *I. kotschyana* and *I. alpina* between Sect. *Isatis* (*Glastum*) and *Samerarioides*, and *I. cochlearis*, *I. aucheri* and *I. lusitanica* between Sect. *Isatis* and Sect. *Apterolobus*; the perennial *I. spatella* (a new species described below) has a membranous loculus and wing as in the annual Sect. *Eremoglastum* but is obviously more closely allied to species in Sect. *Isatis*; 3) affinities sometimes cut across sectional characters. *I. iconia* (placed by Boissier in Sect. *Samerarioides*) is so closely allied to *I. glauca* (Sect. *Isatis*) that it has been necessary to treat it as a subspecies of the latter; indeed, even in the same population the fruit wing of *I. glauca* subsp. *iconia* (normally thin) can be thick; the same applies to *I. kotschyana* and probably *I. glauca* subsp. *exauriculata*. By relying too heavily on technical sectional characters, several species have been described that are in fact synonymous with species placed in different sections (e.g. *I. eriocarpa* is synonymous with *I. aucheri*, and *I. leuconeura* with *I. kotschyana*).

The unsatisfactory nature of Boissier's sections has several possible explanations:

- 1) The sections are at least partly artificial, due to *a priori* weighting of fruit characters. The evolutionary relationships of the species have been obscured by convergent evolution, so that some of the taxonomist's sections are polyphyletic.

- 2) Though the sections are basically natural (phenetic), and the product of divergent evolution, their limits have been blurred by inter-sectional hybridisation.

- 3) Due to the reticulate pattern of variation, *Isatis* may be a genus without natural sections—any attempt to define them is therefore bound to be unsatisfactory.

Despite the shortcomings of Boissier's sectional classification, it is difficult to see how a more satisfactory grouping can be achieved. Something can be done to make the sections more natural by taking the general shape of the fruit into account as well as the thickness of the wing, but this treatment (adopted for the Flora) leads to the sections being still more difficult to define. For instance, *I. cappadocica* subsp. *nurihakensis* has narrow, cuneate fruits 3 times as long as broad (as in some members of Sect. *Isatis*), but



PLATE I. *Isatis cappadocica* subsp. *nurihakensis*.



PLATE 2. *Isatis erzurumica*.



its thin wing (only as wide as the loculus) and general affinities (as assessed by a consideration of its vegetative features) lead one to include it in Sect. *Samerarioides* with the rest of the *I. cappadocica* complex; similar considerations have led me to include *I. spatella* in Sect. *Isatis*, since to place it in Sect. *Eremoglastum* would be manifestly unnatural. Circumscribed in this way, the sections may be manipulated to contain species more closely related to one another than to species in other sections, but by doing so they become a guide to relationships rather than an aid in identification. The genus is so large, however, that poorly delimited sections, even if only partly natural, seem better than no sections at all; they serve as signposts in the morphological wilderness. Under such circumstances, an artificial key for identification (cutting across sectional boundaries) is particularly necessary, since any attempt to divide the genus into more natural groups seems likely to be achieved at the expense of easy identification.

#### NEW TAXA AND COMBINATIONS

As the genus will be covered by the first volume of the *Flora of Turkey* (to be published in 1965), only new taxa and new combinations are published here. Drawings of the fruits of nearly all species will appear in the *Flora*.

##### Sect. *Samerarioides* Boiss.

##### *I. cappadocica* Desv., Journ. Bot. 3: 174 (1814).

An extremely polymorphic species whose limits and subdivision remain somewhat uncertain. As accepted here, the species is equivalent to most of Boissier's interpretation of *I. latisiliqua* Steven, though it excludes the latter species itself, a rather distinctive plant confined to Caucasia and poorly represented in herbaria outside the Soviet Union. Steven's species is distinguished from all forms of *I. cappadocica* by having a strongly wrinkled loculus and hispid stem base. The application of the name *I. cappadocica* has long been in doubt, but examination of the type in the Paris herbarium has established its use. The following combinations are made to accommodate the variation found in Turkey; other taxa in the same complex occur in Caucasia (*I. nummularia* Trautv., *I. karjaginii* Schischkin) and Iran (*I. besseri* Trautv., *I. stenophylla* Bornm. & Gauba, etc.) and may require to be treated as additional subspecies of *I. cappadocica*; others remain undescribed. Intermediates occur between some of the subspecies recognised below.

##### subsp. *cappadocica*

Syn.: *I. velutina* sensu Boiss., Fl. Or. 1: 378 (1867), non Boiss. & Huet.

*I. atropatana* Grossh. in Not. Syst. 13: (1950).

Anatolia, Iran, Soviet Armenia.

##### subsp. *steveniana* (Trautv.) Davis, comb. et stat. nov.

Syn.: *I. steveniana* Trautv. in Mém. Acad. Imp. Sci. St. Pétersb., 4: 309 (1845).

*I. psilocarpa* Ledeb., Fl. Ross. 1: 210 (1842).

*Sameraria litvinovii* Busch, in Fl. URSS, 8: 642 (1939).

Anatolia (mainly E.), Caucasia, N. & N.W. Iran.

subsp. **alyssifolia** (Boiss.) Davis, **comb. et stat. nov.**

Syn.: *I. alyssifolia* Boiss., Fl. Or. 1: 378 (1867).

Anatolia (Lycia and Upper Euphrates).

subsp. **subradiata** (Rupr.) Davis, **comb. nov.**

var. **subradiata**

Syn.: *I. subradiata* Rupr., Fl. Cauc., 131 (1869).

*I. latisiliqua* Stev. subsp. *subradiata* (Rupr.) Bordz. in Izv. Kiev Bot. Sada, 12-13: 112 (1931).

Anatolia, Transcaucasia, N. Iraq, W. Iran.

var. **gudrunensis** (Boiss.) Davis, **comb. nov.**

Syn.: *I. leiocarpa* DC., Syst. 2: 567 (1821).

*I. latisiliqua* Stev. var. *gudrunensis* Boiss. ex Buser, Fl. Or. Suppl. 64 (1888).

*I. latisiliqua* var. *hausknechtii* Bornm. in Feddes Rep. Beih. 89(1): 76 (1936).

S. Anatolia, N. Iraq, W. Iran, Lebanon; Syrian Desert?

subsp. **macrocarpa** (Jaub. & Spach) Davis, **comb. et stat. nov.**

Syn.: *I. platycarpa* Jaub. & Spach var. *macrocarpa* Jaub. & Spach, Ill. Pl. Or. 3: t. 224 f. 10 (1847).

S.E. Anatolia, N. Iraq, W. (and N?) Iran, Transcaucasia.

subsp. **nurihakensis** P. H. Davis, **subsp. nov.** Plate 1.

Ab omnibus formis *I. cappadocicae* fructibus latitudine triplo longioribus cuneato-oblongis differt.

*Herba* suffrutescens, 25 cm alta, caulibus et foliis pubescento-villosulis. *Folia* turionum sterilia elliptica petiolata; folia caulina oblanceolata obtuse auriculata. *Caules* superne in racemos parce et simplice ramosi. *Fructus* 24-26 mm longus, versus apicem 8-9 mm latus, inferne angustatus, villosulo-pubescent, latitudine alae loculum aequante, pedicello duplo longior.

Prov. Maraş: Nurihak Dağ—Elbistan, 2500 m, on steep limestone slopes, fruit uniform, 17 vi 1960, *Stainton & Henderson* 5640 (holo. E, iso K).

This plant is so different from all other races of *I. cappadocica* in its more elongate, cuneate fruits that it was at first thought to be a distinct species. In other characters, however, it comes very close to *I. cappadocica* subsp. *subradiata* var. *gudrunensis* from Iraqi Kurdistan, and as the fruits of the latter even vary in the direction of the population from Nurihak Dağ (though never becoming cuneate) it seems preferable to include it in that species for the present.

***I. erzurumica*** P. H. Davis, **sp. nov.** Plate 2.

Affinis *I. cappadocicae* Desv. sensu stricto sed caulibus elatioribus panicula majore, fructibus magis rotundatis loculo prominenter rugoso recedit.

*Herba* ut videtur biennis, collo fibroso, indumento caulium et foliorum retrorse et crispe pubescenti. *Folia basalia* oblanceolata, sub anthesi mox marcescentia sed petiolis persistentibus. *Caulis* ad 60 cm altus, ad medium ramis elongatis laxo corymboso-paniculatus, panicula 20 cm lata. *Folia caulina* sessilia, lineari-lanceolata vel etiam oblanceolata, 2-6 cm × 2-8 mm,

auriculis oblongis obtusis provisa, superiora fere exauriculata. Flores in racemos pilosos elongatos laxè dispositi; sepala 2.5 mm sparsim pilosa; petala 4 mm, lamina anguste obovata. Fructus orbiculari-ellipticus, late alatus, 7-9(-14) × 5-7(-12) mm, basi rotundatus, apice obtusissimus vel emarginatus, breviter et dense velutinus, raro glaber, ala membranacea loculo 1.5-2-plo latiore radiatim subundulata, loculo elliptico uninerve, 3-4 × 1.5-2 mm, prominenter rugoso.

Prov. Erzurum: Aşkale—Bayburt, Schotterhange 11 km nordwestlich Aşkale, 1680 m, 27 vi 1951, Huber-Morath 11,015 (holo. Herb. Huber-Morath, Basel); Tortum Göl, 1250 m, wayside banks, 9 vii 1960, Stainton & Henderson 6125; Tortum, 8 km nordöstlich Tortum, Kalkschiefer, 1450 m, 16 vii 1958, Huber-Morath 14,845; distr. Tortum, Tortum—Artvin, Westhange ob dem Tortum-See, 52 km nordöstlich Tortum, 1100 m, 16 vii 1958, Huber-Morath 14,844 (forma siliculis majoribus); distr. Olty (Oltu), in declivibus saxosis, 12 vii 1906, E. Koenig (TBI); distr. Olty (Oltu), prope stationem Solanie Promysly, 16 vii 1910, P. V. Nesterov (LE); c. stationem Promezhutochnaya, 25 vii 1925, Roop (TBI). Prov. Erzincan: Erzincan—Refahiye, Bachgeröll 29 km nordwestlich Erzincan, 1560 m, 7 vii 1955, Huber-Morath 13,109.

Closely allied to *I. cappadocica* subsp. *cappadocica* from which it differs in its taller stems bearing a larger panicle, and more rounded, often emarginate fruits with the loculus covered with horny bosses and wrinkles; the last feature is characteristic of the Caucasian *I. latisiliqua* Stev. which differs, however, in its hispid stem base and larger fruits. Many of the specimens of *I. erzurumica* are grazed, but it appears to be biennial, whereas *I. cappadocica* is perennial; the leaves have usually withered by the time the plant is in fruit.

### *I. pinnatiloba* P. H. Davis, sp. nov. Plate 3.

Ad formam fructus affinis *I. cappadocicae* Desv. (praesertim subsp. *stevianiae* (Trautv.) Davis et subsp. *alyssifoliae* (Boiss.) Davis), sed habitu bienni, foliis basalibus lyrato-pinnatilobatis facile distinguitur.

Herba biennis (raro subperennans), saepe elata, ex toto glaberrima, radice crassa. Folia basalia rosulam formantia, membranacea, glauca, deinde purpurascens, saltem externa lyrato-pinnatilobata, undulata, lamina 3-14 × 1.5-7.0 cm, lobo terminali magno obtuso, in petiolum subaequilongum superne alatum sensim angustata. Caulis ad 60 cm altus et 6 mm latus, purpurascens, ad medium vel infra racemis elongatis in paniculam corymbosam 15-20 cm latam dispositis. Folia caulina sessilia, oblonga, integra, obtusa, 4-7 × 1-3 cm, auriculis rotundatis c. 5 mm longis obtusis provisa, ea paniculae minora oblanceolata vel linearia, brevissime auriculata vel exauriculata. Flores sepalis 2-8-3 mm glabris, petalis 5 mm obovatis. Fructus orbicularis, late alatus, apice rotundatus vel emarginatus, pedicello gracili aequilongus, ala loculo multo latiore subundulata membranacea, loculo laevi haud prominente tenuissime unicostato.

Prov. Muğla: Marmaris to Emecik, 200 m, rocky serpentine hills, biennial, fl. lutea, 25 iii 1956, Davis & O. Polunin (D. 25,334—holo. BM, iso. E, K). Limestone sea cliffs just before entrance of Bozburun harbour, 50-100 m, 8 vi 1962, Dudley (Davis 35,472, spec. unica).

A distinctive species apparently confined to coastal areas in S.W. Anatolia (Caria), where it is the most westerly representative of Sect. *Samerarioides* in the Near East. In fruit shape it comes closest to those races of *I. cappadocica* Desv. mentioned in the diagnosis, but is easily distinguished by its biennial habit and pinnately lobed basal leaves, characteristically glabrous and purplish. Dudley's specimen, though the only one with ripe fruit, is obviously untypical in habit. Two specimens collected by Huber-Morath (both without basal leaves), if not conspecific are at any rate closely allied: Muğla: Dalman—Göçak, 120 km südöstlich Muğla, Macchie, 250–300 m, 20 vi 1954, *Hub.-Mor.* 13,111; Muğla: Muğla—Fethiye, 116 km nach Muğla, *Pinus brutia* Wald, 6 km ob Gölçuk, 300 m, 7 vi 1938, *Hub.-Mor.* 5,729. The first of these differs from the type in its acute stem leaves and flat fruits with a subcordate base; the second differs more markedly in its serrate and acute stem leaves and smaller, broadly elliptical fruits (9–11 × 7–9 mm) which resemble those of *I. candolleana* Boiss. from E. Anatolia.

The following gathering from the Amanus, very similar to *I. pinnatiloba* in leaf shape and habit, may represent an allied new species: Hatay distr. Belen: Karlik Tepe above Söğuk Oluk, 1200 m, igneous scree, *Davis* 27,092. It differs in its lower leaves being pubescent and in the very immature orbicular fruits having a winged midrib as in *I. callifera* Boiss. and *I. lockmanniana* Boiss. (both S. Anatolian species). Material with ripe fruits is required.

***I. bitlisica* P. H. Davis, sp. nov. Plate 4.**

Affinis *I. cappadocicae* Desv. subsp. *stevenianae* (Trautv.) Davis et *I. sivasicae* Davis; a priore foliis caulinis brevissime auriculatis vel exauriculatis, panicula brevior simpliciore recedit; ab altera foliis viridibus membranaceis, fructibus latioribus undulatis distinguitur.

*Herba* valde perennis, multicaulis, basi suffrutescens. *Folia* basalia anguste oblanceolata, sensim petiolata, mox marcescentia. *Caules* 50–60 cm alti, 3 mm lati, pallidi, glabri, graciles, superne ramis arcuato-ascendentibus breviter corymboso-paniculati, panicula 10–13 cm lata. *Folia* caulina viridia, membranacea, glabra, oblonga vel oblongo-oblanceolata, 5–9 × 1–2.2 cm, subacuta, basi rotundata vel etiam attenuata brevissime auriculata vel exauriculata, inferiora in petiolum brevem attenuata, superiora linearia diminuta. *Flores* in racemos breves vel elongatos dispositi; sepala 2.5–3 mm, glabra; petala 4–5 mm, obovata. *Fructus* immaturus late ellipticus vel suborbicularis, glaber vel velutinus, ala membranacea undulata loculo obscuro multo latiore, costa mediana tenui; stigma sessile vel brevissime stipitatum.

Prov. Bitlis: Kambos Dağ, 1950 m, with *Isatis* 23,394, on rocky N. slopes, fruit glabrous, 1 vii 1954, *Davis* & *O. Polunin* (*D.* 23,396—holo. E, iso. K); Kambos Dağ above Hurmuz, 2100 m, rocky N. slope, perennial, many-stemmed (with *Isatis* 23,396), *Davis* & *O. Polunin* (*D.* 23,394).

Only known from one mountain S.W. of lake Van, and apparently closely allied to *I. cappadocica* (approaching subsp. *steveniana* in fruit shape) and *I. sivasica* (see diagnosis for differences). Both glabrous and hairy-fruited variants were found in the same population. In the form of its inflorescence (with short, somewhat arcuate branches) it resembles *I. cappadocica* subsp. *alyssifolia* (Boiss.) Davis.

**I. sivasica** P. H. Davis, *sp. nov.*

Affinis *I. glaucae* Boiss. subsp. *iconiae* (Boiss.) Davis et *I. bitlisicae* Davis; a priore foliis minus crassis, fructibus latioribus differt; ab altera foliis glaucis, paniculis latioribus et forma fructus recedit.

*Herba* perennans, elata, eximie glauca, gracilis, ex toto glaberrima. *Folia basalia* mox marcescentia, lineari-oblancheolata, sensim petiolata. *Caules* pallidi, inferne eburnei, 50–80 cm alti vel ultra, supra in paniculam elongatum 15–30 cm latam laxè ramosi. *Folia caulina* sessilia, crassiuscula, integra, oblancheolata, acuta, brevissime acute auriculata, superiora linearia minora exauriculata. *Flores* in racemos brevissimos dispositi; sepala 2–2.5 mm; petala 4–5 mm. *Fructus* ovato-rhomboideus vel late ovatus, 14–16 × 7–12 mm, planus, glaber, pallidus, basi rotundata vel etiam subcordatus, apice subacutus, ala membranacea loculo multo latiore retrorse venulosa, loculo haud prominenti costa mediana tenui proviso.

Prov. Erzincan: Pigana, Kurutschai (Hassanova), in herbidis, 27 vi 1889, *Sintenis* 973 (holo. W, iso. K). Prov. Sivas: pr. Zara, 1300–1400 m, v 1893, *Bornmüller* 3257; champs à Sivas, 7 vii 1891, *Girard*; 17 km südwestlich von Sivas am Weg nach Şarkışla, in rupestribus, 15 vi 1939, *Reese*; Sivas—Zara road, half way, 1200 m, on gypsum banks, *Stainton & Henderson* 5794.

An overlooked species, probably confined to Cappadocia, that has been previously referred to *I. glauca* Boiss., *I. iconia* Boiss. & Heldr. or *I. latisiliqua* Stev. As stated in the diagnosis, it seems closest to the Anatolian *I. glauca* subsp. *iconia* and to *I. bitlisica* Davis from Turkish Kurdistan.

**I. amani** P. H. Davis, *sp. nov.*

Affinis *I. undulatae* Boiss. sed caulibus glabris, foliis caulinis diversis, fructibus breviter tomentosis valde differt.

*Herba* perennis, saltem 50 cm alta, turione sterili provisa. *Folia basalia* elliptica, integra, 2.5–4.5 × 1–2.5 cm, hirsuta, in petiolum aequilongum attenuata. *Caulis* glaber, purpurascens, gracilis, superne in racemos elongatos laxè ramosi, panicula 15–20 cm lata. *Folia caulina* glabra vel margine ciliata, glauca, membranacea, inferiora petiolata, marcescentia, mediana ovato-oblonga, acuta vel acuminata, auriculis magnis ovatis obtusiusculis amplexi-caulibus, superiora multo angustata sensim acuminata auriculis oblongis divergentibus provisa. *Flores* sepalis 2.5 mm glabris, petalis 4 mm. *Fructus* late obovato-oblongus, immaturus 10 × 6 mm, pedicello duplo longior, apice truncatus et emarginatus, breviter et dense tomentosus (pilis loculum unicostatum obtegentibus), ala ut videtur membranacea loculo multo latiore.

Prov. Hatay: Mount Amanus, 2250 m, vi 1906, *Haradjian* 714 (holo. Hb. Delessert, G).

A very distinct plant (previously determined as *I. aucheri* Boiss.) which is apparently most closely allied to *I. undulata*, a little-known species from the Upper Euphrates. The glabrous, purplish stems bearing very glaucous, glabrous, large-auricled, cauline leaves are reminiscent of *I. candolleana* Boiss., but other characters of the plant preclude any close affinity.

The remaining two Turkish species in Sect. *Samerarioides* are:

**I. candolleana** Boiss. (*I. velutina* Boiss. & Huet (*sensu orig.*), *I. conringifolia* Bornm.).

**I. undulata** Aucher ex Boiss.



Sect. *Isatis* (Sect. *Glastum* Boiss.)

**I. glauca** Aucher ex Boiss. in Ann. Sci. Nat. 17: 201 (1842).

Copious material forces me to take a wide circumscription of this species which is centred in Inner Anatolia. It includes plants with a fruit wing that is either thick or thin. The following partly allopatric subspecies can be recognised.

subsp. **glauca**

Syn.: *I. glauca* var. *collina* Boiss., Fl. Or. 1: 370 (1867).

*I. lanceolata* Stapf in Denk. Akad. Wiss. Wien Math.-Nat. Kl., 51: 18 (1886).

The most widespread and abundant subspecies.

subsp. **iconia** (Boiss. & Heldr.) P. H. Davis, **comb. et stat. nov.**

Syn.: *I. iconia* Boiss. & Heldr. in Boiss., Diagn. sér. 1(8): 48 (1849).

subsp. **exauriculata** (Bornm.) P. H. Davis, **comb. et stat. nov.**

Syn.: *I. exauriculata* Bornm. in Mag. Bot. Lap. 30: 56 (1931).

It is very likely that *I. grossheimii* Busch, from Soviet Armenia, is synonymous and provides an earlier binomial.

**I. tinctoria** L., Sp. Pl. 670 (1753).

Syn.: *I. canescens* DC., Fl. Fr. 598 (1815).

Three races of this very polymorphic and widespread species can be distinguished in Turkey:

subsp. **tinctoria**. Incl. *I. tinctoria* var. *vulgaris* Koch.

subsp. **tomentella** (Boiss.) P. H. Davis, **comb. et stat. nov.**

Syn.: *I. tinctoria* var. *stenocarpa* Boiss., Fl. Or. 1: 381 (1867), non Griseb. (1843).

*I. tomentella* Boiss., Diagn. sér. 2(5): 46 (1856).

subsp. **corymbosa** (Boiss.) P. H. Davis, **comb. et stat. nov.**

Syn.: *I. corymbosa* Boiss. in Ann. Sci. Nat. 17: 200 (1842).

**I. spectabilis** P. H. Davis, **sp. nov.**

Affinis *I. tinctoriae* L. sed caule angulari, inflorescentia magna pyramidali, auriculis foliorum caulinarum obtusis, fructibus magis attenuatis sursum curvatis ala lateraliter obtusissima recedit.

*Herba* biennis, robusta, 1 m alta vel ultra. *Folia basalia* oblanceolato-elliptica, pubescentia vel glabrescentia, lamina ad 20×6 cm, repando-denticulata vel subintegra, in petiolum breviorē attenuata. *Caulis* acute angularis, basi saltem 1 cm latus, infra medium in paniculam pyramidalem 1 m latam e paniculis subcorymbosis compositam multo ramosus. *Folia caulina* sessilia, oblonga vel lanceolata, acuta, 6–10×1–2.5 cm, membranacea, glaucescentia, integra, basi auriculis triangulari-ovatis 5–10 mm longis provisa. *Flores* in racemos densos dispositi; sepalia 2.5 mm; petala 3.5–4.5 mm, lamina oblongo-obovata. *Fructus* angustissime cuneato-oblongus, 20–24×3.5–4.5 mm, glaber, pedicello 2–3-plo longior, apice breviter

emarginatus, infra loculum medianum vel supra-medianum sensim angustatus, ad loculum sursum curvatus, ala crassa lateraliter obtusissime marginata inflato-fungosa latitudinem loculi tenuiter unicostati aequante, versus apicem et basin magis complanata. Fl. Jun.

Prov. Tunceli: Pülümür, 1600 m, igneous slopes, broad pyramidal inflorescence, 11 vii 1957, *Davis & Hedge* (D. 30, 924, holo. E, iso. K); Tunceli—Pülümür, 30 miles from Tunceli, 1300 m, river bank and edge of fields, biennial, stem 1 m or more, bearing a very wide spectacular panicle, fl. lutea, 7 vi 1957, *Davis & Hedge* (D. 29, 245).

A very striking species whose wide pyramidal panicle is visible for miles on the hillsides. Related to *I. tinctoria* from which it differs in its angled stem, different inflorescence, obtuse auricles and more attenuated fruits (bent upwards at the loculus) with an inflated and very obtuse lateral wing.

### *I. constricta* P. H. Davis, sp. nov.

Affinis *I. tinctoriae* L. sed foliis subcrassioribus caulinis obtuse auriculatis, fructibus ad loculum supra medianum constrictis divergit.

*Herba* biennis vel breviter perennans. *Folia* crassiuscula, glabra, glauca (in sicco saepe nigricantia), basalia turionis sterilis ovata subintegra in petiolum attenuata, basalia caulis floriferi oblongo-linearia irregulariter et breviter dentato-pinnatilobata, in petiolum alatum sensim attenuata. *Caulis* 40–50 cm altus, obtuse angularis, glaber, in paniculam subcorymbosam 25–30 cm latam racemis divaricatis bis ramosus. *Folia caulina* mediana sessilia, oblonga, integra (superiora lanceolata diminuta), 4–5 cm × 5–12 mm, auriculis triangulari-ovatis obtusis 3–5 mm longis provisa. *Flores* in racemos ± breves dispositi, parvi, sepalis 1.5 mm glabris purpureo-fuscis, petalis 3 mm. *Fructus* lineari-oblongus, 14–18 × 3–4 mm, dense pubescens, pedicello duplo longior, ad loculum supramedianum paulo constrictus, apice subtruncatus saepe brevissime emarginatus, basi rotundatus, ala inflato-fungosa latitudine loculi tenuiter unicostati angustiore vel aequilata lateraliter obtusa.

Prov. Elazığ: Maden, 1300 m, igneous N.W. slope, 2 vi 1957, *Davis & Hedge* (D. 29, 083, holo. E, iso. K); N. side of Hazar Göl, 1200 m, igneous slopes, 4 vi 1957, D. 29, 088; 28 km S. of Maden, 27 v 1959, *It. Leyd.* 1533 (forma caule brevior, auriculis acutis—verosimiliter depauperata).

Closely allied to *I. tinctoria* L. but apparently distinct in the characters cited in the diagnosis; in fruit shape it is closer to *I. floribunda* Bornm. but differs markedly in other characters. The description of the flower is taken from *It. Leyd.* 1533 which is probably an untypical specimen. In flower, leaf and habit the species approaches *I. koelzii* Rech. fil. from Afghanistan. As in that taxon, there is a tendency to produce occasional fruits with two loculi.

Although material with ripe fruits has only been seen from the Mader area of the Upper Euphrates, the following flowering material from the Cilician Taurus and Anti-Taurus may be conspecific: Prov. Içel: distr. Selefke, Cataracten des Lamasflusses im O. von Mara, *Siehe* 416 (as *I. glauca*). Prov. Seyhan: in montibus Kassar Oghlu ad pagum Gorumse, versus Cedretum, 1300 m, *Kotschy* 100 (referred by Boissier to *I. callifera*). In most of this material the ovary is glabrous.

**I. huber-morathii** P. H. Davis, *sp. nov.* Plate 5.

Ab *I. callifera* Boiss. habitu perenni, foliis crassioribus caulinis brevissime auriculatis, loculo fructus uncostato transverse spongioso-ruguloso inter alia differt. Ab *I. glauca* Boiss. (sensu lato) habitu diverso, foliis caulinis angustatis et praesertim forma fructus valde diversa recedit.

*Herba* perennis, e radice crassa collo fibroso pluricaulis caespitosa, ex toto glaberrima. *Folia basalia* rosularum fertilium et sterilium crassa, obovata,  $2-3 \times 1-1.5$  cm, obtusa, glauca, in petiolum 1-2-plo longiorem attenuata. *Caules* 25-30 cm alti, infra medium racemis elongatis in paniculam laxam c. 15 cm latam sparsim dispositis. *Folia caulina* mediana sessilia, linearia, crassiuscula, subacuta, basi auriculis brevissimis rotundatis provisa; folia paniculae minora vix auriculata. *Flores* sepalis 2 mm glabris, petalis 3 mm. *Fructus* (vix maturus) pedicello aequilongo gracillimo sigmoideo-recurvo suffultus, obovato-oblongus,  $8 \times 3$  mm, obtusus, basi breviter attenuatus, ambitu tenuiter (?) alatus, ala venulosa ad loculum 0.75 mm lata, loculo mediano prominente,  $4 \times 1.5$  mm, transverse spongioso-ruguloso, costa mediana obscura proviso.

Prov. Kayseri (Cappadocien): Sopan Dağ 15 km südlich Pinarbaşı, Serpentschiefer, 1590-1620 m, 22 vi 1951, A. Huber-Morath 11,017 (holo, Hb. Huber-Morath, Basel).

The affinity of this serpentine species from the Anti-Taurus is somewhat doubtful. It approaches *I. glauca* Boiss. (*s. lato*) in its thick, shortly auricled (though much narrower) stem leaves, but differs so strikingly in fruit shape that the relationship cannot be considered close. The fruit is closest to that of the Cilician *I. callifera* Boiss., but the new species differs strongly from the latter in its perennial habit, in the form and texture of the leaves, and in the loculus of the fruit bearing transverse spongy wrinkles and a slender midrib (in *I. callifera* the loculus is 3-ribbed, the midrib being winged and the lateral ribs becoming spongy). As the fruit of *I. huber-morathii* is unripe, it is impossible to tell if the wing is going to remain thin (in *I. callifera* it is thickened). An unusual feature of the new species is the sigmoid curvature of its fruiting pedicels—a character reminiscent of *Thlaspi* and observed in no other Turkish species of *Isatis*.

It is a pleasure to name this plant after its discoverer, Dr. A. Huber-Morath, whose botanical exploration in Anatolia and critical revisions have done so much to further our knowledge of the Turkish flora.

**I. spatella** P. H. Davis, *sp. nov.* Plate 6.

Affinis *I. cochleari* Boiss. sed habitu valde perenni, forma foliis diversa, fructibus minimis anguste membranaceo-alatis differt.

*Herba* valde perennis, gracilis, ex toto glaberrima, caudiculis collo fibroso provisis. *Folia basalia* surculorum sterilium parva, membranacea, glauca, lamina obovata subrepanda  $2-3 \times 1-1.5$  cm, in petiolum tenuem triplo longiorem attenuata, deinde purpurascens. *Caulis* 45 cm altus, tenuis, teres, 2 mm latus, purpureus, superne racemis brevissimis densis in paniculam laxam c. 15 cm latam dispositis. *Folia caulina* mediana sessilia, oblonga, c.  $3 \times 0.8$  cm, subintegra vel obscure et remote denticulata, obtusa, basi auriculis acutis triangularibus  $2-3$  mm longis provisa. *Pedicelli* gracillimi in fructu deflexi superne incrassati fructu subduplo longiores. *Flores* perfecti

Savin 25, 1934, & D. Collins.  
Isatis.

Turkey, Prov. Angora, Karacalis-Iskeli,  
200 m., rocky serpentine hills.  
Herbar. Fl. lates. 25 March 1950.



PLATE 3. *Isatis pinnatifida*.

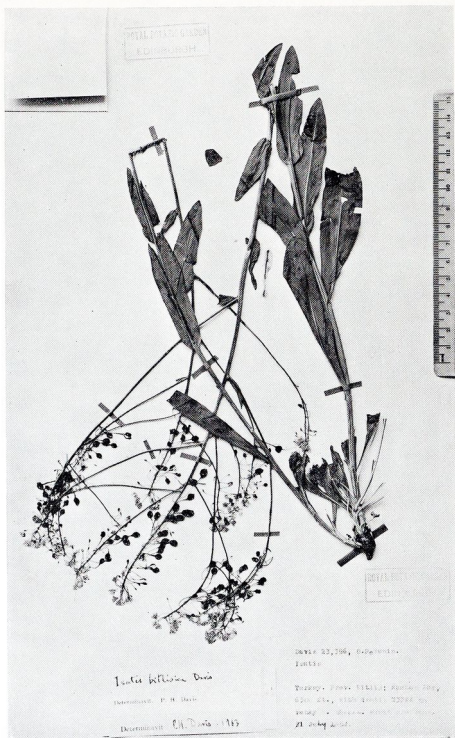


PLATE 4. *Isatis bitlisica*.





PLATE 5. *Isatis huber-morathii*.

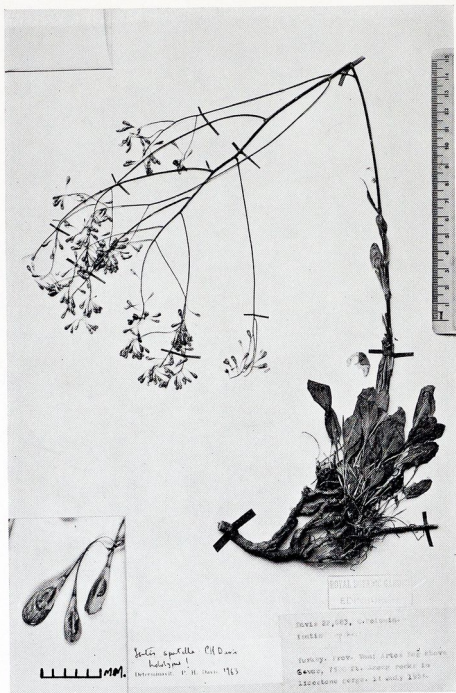


PLATE 6. *Isatis spatella*.

ignoti (eis monstrosis sepalis glabris 3.5 mm). *Fructus* minimus nitidus, obovatus, 5 × 2 mm, obtusissimus, basi breviter attenuatus, infra loculum incrassatus, loculo submediano membranaceo 2-2.5 × 1.5 mm, tenuiter inicostato lateraliter angustissime membranaceo-alato, ala supra loculum subconcaua membranacea.

Prov. Van: Artos Dağ above Gevaş, 2250 m, among rocks in limestone gorge, 14 vii 1954, Davis & O. Polunin (D. 22,683—holo. E, iso. K).

A very distinctive plant, closest to *I. cochlearis* Boiss. (from Turkish Mesopotamia and N. Iraq) in the general form of its fruit, but differing in its strongly perennial habit (with numerous sterile shoots), different leaf shape, and much smaller silicules with a narrow membranous wing. The membranous texture of the loculus and wing does not allow it to be accommodated in Sect. *Isatis* without some modification of the latter's description; it is clear, however, that its affinities are here and not in the annual Sect. *Eremoglastum* which resembles the new species in having a membranous loculus and wing.

A puzzling specimen from Hakâri (Cilo Tepe, 3100 m, rocky slope, 8 viii 1954, D. 24,080) comes nearest to *I. spatella*, but is a larger stouter plant with puberulent fruits twice the size; the silicules resemble those of *I. cochlearis* in general shape and size, but have the narrow membranous wing of *I. spatella*. Its taxonomic position is uncertain.

The other species belonging to Sect. *Isatis* in Turkey are as follows:

- |   |   |
|---|---|
| <b>I. arenaria</b> Azn.   | <b>I. kotschyana</b> Boiss. & Hoh.  |
| <b>I. aucheri</b> Boiss. ( <i>I. hispida</i> Post,<br><i>I. eriocarpa</i> Blakelock). | <b>I. kozlowskyi</b> Grossh.  |
| <b>I. callifera</b> Boiss. & Bal.   | <b>I. lockmanniana</b> Kotschy ex Boiss.  |
| <b>I. cochlearis</b> Boiss.   | <b>I. lusitanica</b> L. ( <i>I. aleppica</i> Scop.,<br><i>I. pyramidata</i> Stapf). |
| <b>I. floribunda</b> Boiss. ex Bornm.   | <b>I. takhtajanii</b> Avet. (Izv. Akad. Nauk<br>Arm. 14 (3): 77, 78 f. 1, 1961).    |
| <b>I. frigida</b> Boiss. & Kotschy.   |   |

The only Turkish species in Sect. *Apterolobus* is the neglected *I. buschiana* Schischkin, to which Anatolian records of *I. iberica* Stev. should be referred.