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A study of the morphological variability in *Cynara humilis* L. and *C. hystrix* Ball (*Asteraceae-Cardueae*)

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Resumen: Wiklund, A. *Estudio de la variabilidad morfológica de Cynara humilis L. y C. hystrix Ball (Asteraceae-Cardueae). Lazaroa 11: 19-27 (1989).*

El estudio de los especímenes de herbario, recolectados en la Península Ibérica y Marruecos, y que han sido atribuidos a *Cynara humilis* L y *C. hystrix* Ball ha puesto de manifiesto la variabilidad de ciertos caracteres, mucho más notable en el material marroquí. La representación mediante símbolos, en un mapa, de la distribución de seis de los caracteres morfológicos seleccionados, permite comprobar la existencia de formas intermedias, que se situan en la zona de contacto entre las áreas marroquíes de ambos táxones. Se discute la posibilidad de explicar este hecho, como resultado de un proceso de hibridación alopátrica introgresiva.

Abstract: Wiklund, A. *A study of the morphological variability in Cynara humilis L. and C. hystrix Ball (Asteraceae-Cardueae). Lazaroa 11: 19-27 (1989).*

The two species *Cynara humilis* L. and *C. hystrix* Ball of the *Asteraceae-Cardueae* were found to intergrade in Morocco. A pictorialised dot map, showing the distribution of six characteres in Moroccan herbarium specimens of the above species and intermediate morphs, was produced. The map revealed a pattern that suggests the occurrence of allopatric introgressive hybridisation.

During a revision of the genus *Cynara* L. (*Asteraceae-Cardueae*) which is presently being undertaken, it was found that *C. humilis* L. and *C. hystrix* Ball present a bewildering morphological variation, without distinct limits between the two species, in the mountain regions of Morocco. In order to shed some light on the problem a pictorialised dot map (DAVIS & HEYWOOD, 1973) was produced, showing the distribution of selected morphological characters in all available mature herbarium collections of *C. humilis*,

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C. hystrix and intermediate morphs from Morocco and adjacent areas in North Africa.

MATERIAL AND METHODS

This study is based entirely on herbarium specimens from the following herbaria (for abbreviations see HOLMGREN & al. 1981): BM, G, GDA, K, MA, MAF, MPU, P, S, SEV, VF & W).

The morphological study and the descriptive terminology follow WIKLUND (1985). Measurements of the leaf rachis were taken from its broadest part.

OBSERVATIONS

Cynara humilis is an easily recognizable and distinctive species within the genus, characterized by its very narrow-lobed, bipinnatifid leaves (fig. 1A) and its cypselas with four wing-like longitudinal ribs along the ed-

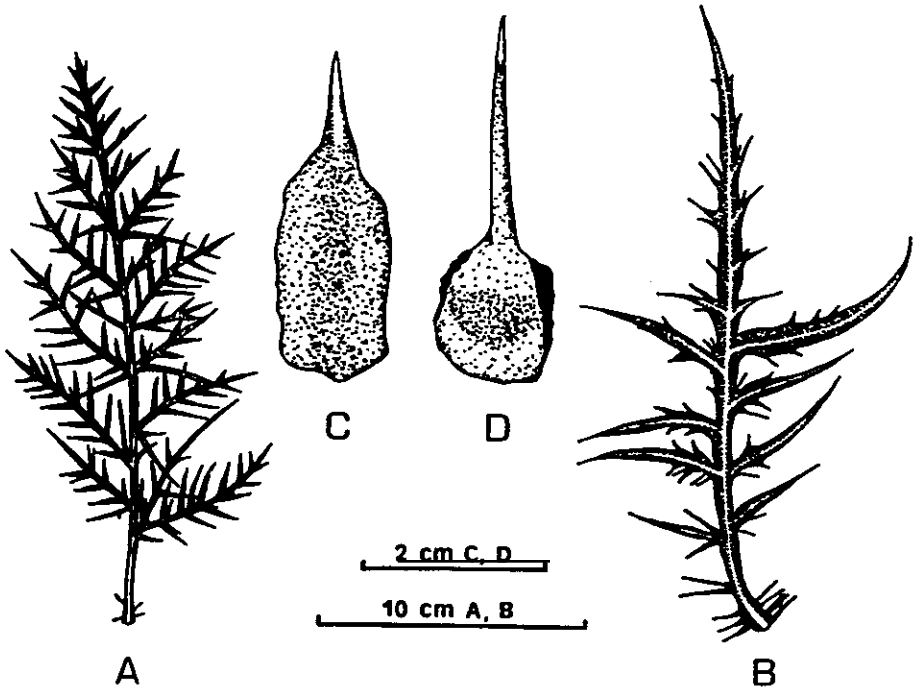

Fig. 1.—A: *Cynara humilis*, cauline leaf — B: *C. baetica*, cauline leaf — C: *C. humilis*, middle involucrat bract — D: *C hystrix*, middle involucral bract — A & C: Rivas-Martínez & al., Toledo, Escalona, 1974 (MAF) — B: Devesa, Córdoba, Priego de Córdoba, El Chaparral, Sierra de Horconera, 1977 (SEV) — D: Sennen & Mauricio 7897 (BM).

ges. It occurs in the central and South-Western part of the Iberian peninsula and in North-Western Africa.

For this study only *C. humilis* specimens from the Iberian peninsula, outside the area of distribution of the Moroccan *C. hystrix*, have been selected to represent «typical» *C. humilis*. Since hybrids have been reported between *C. humilis* and the South-West Iberian *C. algarbiensis* (TALAVERA, 1987) care was taken to avoid *C. humilis* specimens occurring within the areas sof distribution of the latter. In addition *C. humilis* specimens from the areas of distribution of other Iberian *Cynara* species were as much as possible avoided.

In the Iberian peninsula *C. humilis* has been collected at altitudes between 25 and 1000 m in fields, pastures and waste grounds on siliceous and calcareous substrates. Its flowering time is between May and July (fide coll.) and its chromosome number is reported to be $2n = 34$ (FERNANDES & QUEIRÓS 1971).

A characterization of the Moroccan endemic *C. hystrix* proved to be more difficult, since no geographically delimited and morphologically homogeneous population was found. However, during the presently undertaken revision of the genus it has been found that, apart from different pigmentation of florets and involucral bracts, no distinct differences exist between *C. hystrix* and the South Spanish *C. baetica* (Spreng.) Pau (syn. *C. alba* Boiss. ex DC).

Similar intraspecific colour variations have been seen to be common within *Cynara* and a taxonomic recognition of the two above species based solely on this character is here not considered to be justified. *C. hystrix* and *C. baetica* together, on the other hand, have been found to form a distinct and well-delimited entity, defined by the presence of dark-coloured scarious rims on the involucral bracts (fig. 1D), a character which is absent in *C. humilis* (fig. 1C) and in the other *Cynara* species. They are therefore here found to be best regarded as conspecific. A taxonomic and nomenclatural treatment of the two taxa will be included in the revision of the genus (Wiklund in MS).

C. baetica is thus here considered to form a part of «*C. hystrix* s. l.» and its morphological characters are used in this study to represent «typical» *C. hystrix*. *C. baetica* is a morphologically quite homogeneous taxon with broad-lobed, pinnatifid to ± bipinnatifid leaves (Fig. 1B) and ± smooth cypselas without conspicuous ribs. It has been collected at altitudes between 500 and 1700 m, in fields and at the roadside on calcareous and clayey soils. Flowering specimens have been seen from August and September. The chromosome number is reported to be $2n = 34$ (TALAVERA, 1981).

A comparison between «typical» *C. humilis* and «typical» *C. hystrix* as defined above, revealed a number of differences in characters such as type and degree of branching, degree of incision of leaf lobes and lobules, length of leaf spines, density of dorsal leaf indumentum, amount of dorsal

Table 1

Characters in *Cynara humilis* and *C. hystrix* s.l. Symbols correspond to symbols in the pictorialised dot map (Fig. 2)

Character	*C. humilis*		*C. hystrix*
Width of leaf rachis (mm).	1.5-4	4.1-4.9	5.0-16
Lengt of leaf spines (mm).	2-4		7-12
Density of dorsal leaf indementum	densely woolly	moderately woolly	slightly woolly
Sabrid hairs on ventral leaf surface	absent		present
Length of protrusion of middle involucral bracts (mm).	7-19	20-25	26-32*
Dark-coloured scarious rims on on involucral bracts.	absent	minute	distinct

* The bracts of *C. baetica* protrude between 17 and 30 mm. However, since all measurements of this character from ± *C. baetica*-like collections in Morocco fall within the upper part of the range of varation of *C. baetica* or exceed it, is has here been assumed that ± longer protrusions of the involucral bracts are characteristic of the Moroccan population of '*C. hystrix* s.l.' and only measurements from otherwise *C. baetica*-like specimens in Morocco have been added to this table.

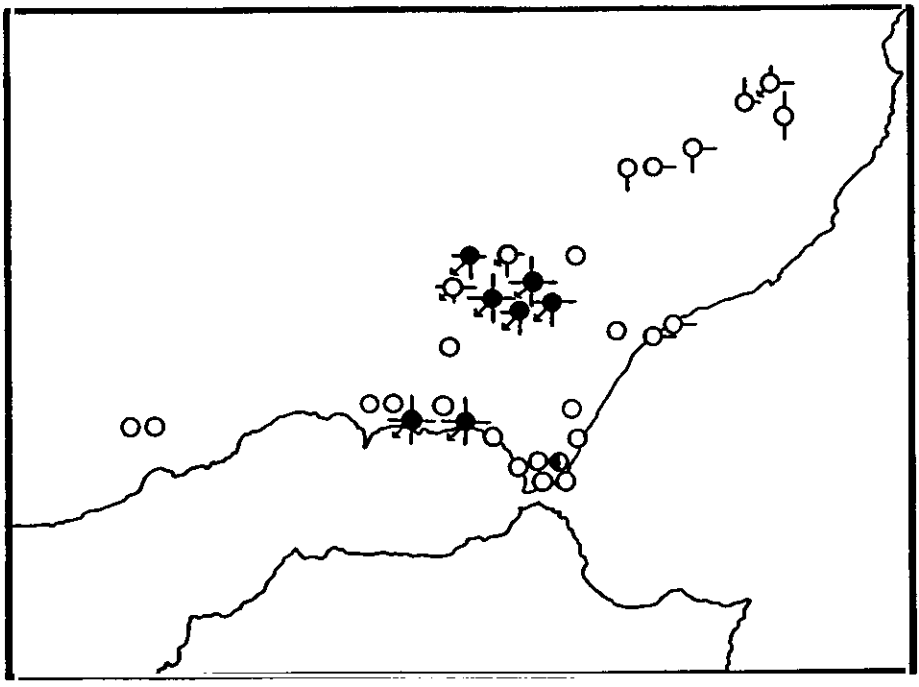

Fig. 2.—Pictorialised dot map showing the distribution of mature specimens of *C. humilis, C. hystrix* and intermediate morphs in N. W. Africa. For explanation of symbols see table 1. Where specimens from the same locality have the same symbol only one is shown on the map.

leaf glands, presence or absence of scabrid hairs on ventral leaf surface, degree of protrusion of middle involucral bracts, presence of dark-coloured scarious rims on involucral bracts and shape of cypselas. Of these characters six proved suitable for a pictorialised dot map, as expressed in Table 1, viz the degree of incision of the leaf lobes, the length of the leaf spines, the density of the leaf indumentum, the occurrence of scabrid hairs, the degree of protrusion of the involucral bracts and the occurrence of dark, scarious rims on the involucral bracts.

RESULTS AND DISCUSSION

The resulting pictorialised dot map (Fig. 2) shows an occurrence of «typical» *C. humilis* in the more or less low-lying areas of North-Western Morocco and also in the mountainous regions of North (Rif) and central (Middle Atlas) Morocco. The Moroccan specimens of «typical» *C. humilis* were found to have been collected in fields, pastures and waste grounds

at altitudes between 40 and 1250 m. Their flowering time was seen to be in June and July. This largely agrees with what was observed in specimens of *C. humilis* from the Iberian peninsula.

The eastern part of the area of distribution of Moroccan «typical» *C. humilis* was found to greatly overlap the area of distribution of «typical» *C. hystrix*. The latter was found to occur in habitats similar to those of *C. humilis* the Rif and Middle Atlas mountains. The *C. hystrix* specimens had been collected at altitudes between 1000 and 1900 m and flowering specimens were seen from July and September. The above characteristics of Moroccan *C. hystrix* agree in general with what was found for the South Spanish population of «*C. hystrix* s.l.» (= *C. baetica*), although the Moroccan specimens appear to start their flowering earlier than the Spanish ones.

More or less intermediate morphs were found to occur in the area of overlap between «typical» *C. humilis* and «typical» *C. hystrix* in the Middle Atlas mountains. Intermediate morphs were also found in the High Atlas mountains, South of the areas of distribution of both *C. humilis* and *C. hystrix*. In addition, a few collections from the Moroccan West coast, that had initially been regarded as «typical» *C. humilis*, were found to belong to the intermediate morphs. No intermediaries were found in the Rif mountains, where both «typical» *C. humilis* and «typical» *C. hystrix* occur.

No distinct differences in choice of habitat between the intermediate morphs and «typical» *C. humilis* or «typical» *C. hystrix* could be detected in the scanty information available on the herbarium labels, although a more common occurrence in cultivated or othervise disturbed habitats seemed to be the case. The intermediate morphs were found to occur in a wide range of altitudes, from near sea-level up to 1900 m. Their flowering time was also found to be wide-ranging, flowering specimens being seen between May and August.

A closer study of the intermediate morphs revealed that the more *C. humilis*-like intermediaries, like *C. humilis*, occurred mainly in the Western part of Morocco at relatively lower altitudes (between sea-level and 1450 metres) and flowered early (May and June). The most *C. hystrix*-like intermediaries on the other hand showed, like *C. hystrix*, a more easterly distribution. They were found within the area of distribution of «typical» *C. hystrix* at ± high altitudes (900-1900 m). Truly intermediate morphs were found to occupy ± intermediate heights (900-1500 m) and have their flowering time in July.

Cypselas with embryos were not encountered in any of the intermediate morphs. They were found to be uncommon in «typical» *C. humilis* and «typical» *C. hystrix*.

The pictorialised dot map presented here has to be regarded as a very crude illustration of the actual morphological variation in the area, both because of the few herbarium specimens available and because it does not show the variation at populational level. In addition potentially interes-

ting information from artificial crossings and cytological studies is lacking.

Despite the above limitations of this study, I consider that it does give some indications of the causes of the observed variation. In general it is thought that similar patterns of variation, in very variable populations, can arise either from primary or secondary intergradation (see HEISER, 1973). In this case the latter possibility, i.e. hybridisation, is considered to be the most likely. The main reasons for this are that the intermediate morphs were found in the general area of overlap between the areas of distribution of *C. humilis* and *C. hystrix* and the fact that the *C. humilis*-like intermediaries were found in the vicinity of «typical» *C. humilis* whereas the *C. hystrix*-like intermediaries occurred closer to «typical» *C. hystrix*. The scarcity of mature cypselas seems to exclude an important role of apomixis or selfing. The wide range of morphological variation encountered in the intermediate morphs and their occurrence in the High Atlas in Southern Morocco, where neither *C. humilis* nor *C. hystrix* have been found would then indicate the occurrence of introgression.

The fact that no hybrids have been reported from Southern Spain, where the areas of distribution of *C. humilis* and *C. baetica* overlap, may possibly be explained by their different flowering times.

COLLECTIONS

«Typical» *C. humilis*

SPAIN. **Cádiz:** Puerto de Santa María, uncultivated places, 1849, *Bourgeau* 259 (G, P) — Puerto de Santa María, in sand, 1878, *Pérez-Lara* 560 (MAF) — Jerez de la Frontera, TF-65, Encinar de Vicos, village road from Garropilos, 1978, *Martínez* (SEV) — La Barca de la Florida, Dehesa de Malabrigo, 1978, *Devesa & Pastor* (SEV) — Jerez, Ermita del Mimbral, 1877, *Pérez-Lara* 560 (MAF) — Jerez, Dehesa de la Gigonza, 1885, *Pérez-Lara* 560 (MAF) — Tarifa, Loma de la Curva, 1980, *Arroyo* 992/80 (SEV) — Tarifa, N margin of Embalse de Almodóvar, 1980, *Barroso & Gil* 1295/80 (SEV) — Algeciras-Tarifa, –66, *Verdcourt* 4352 (K) — Algeciras, 1887, *Reverchon* 62 (BM, G, S, W) — Ojén valley, Los Barrios, roadsides, 1961, *Borja & Rodríguez* (MA, MAF) — Los Barrios, Dehesa de Ojén, 1961, *Borja & Rivas Goday* (MAF) — Andalucía, San Roque, 1956, *Brinton-Lee* 534 (BM) — On the Gibraltar rock and near San Roque, Schott (W) — Gibraltar, 1925, *Cropper* (BM) — Near Gibraltar, *Schott* (W). **Ciudad Real:** El Molinillo, –77, *Velasco* (MAF). **Córdoba:** Peñarroya, Embalse Sierra Boyera, 1978, *García* (SEV) — Near Córdoba, 1874, herb. *Torre Pando* (MAF). **Málaga:** Sierra Bermeja, 1969, *Ladero* (MAF, VF) — Puerto de la Torre, 1974, *Varo* (GDA) — Málaga, 1852, herb. *Lange* (S) — Kingdom of Granada, near Málaga, Cerro Carronado etc., 1879, *Huter & al.* 375 (G, W) — Andalucía, surroundings of Málaga, 1913, *Brandt* 1582 (S) — Cerro de San Antón, 1913, *Gros* (MA). **Sevilla:** Between Cazalla de la Sierra and Guadalcanal, 1976, *Galiano & al.* 1510/76, 1511/76 (SEV) — Castilblanco de los Arroyos, Hacienda de los Melonares, 1968, *Galiano & Valdés* 1763/68 (SEV). **Toledo:** Escalona, –74, *Rivas-Martínez & al.* (MAF) — village road from El Alamin to Escalona, 1984, *Sánchez-Mata & Molina* (MAF).

MOROCCO:: Tangier, in pasture, 1835, *Salzmann* (MPU); coll. ignot. (W) — Tangier, herb. Bentham (K); *Salzmann* (W); 1935, *Trethewy* 23 (K) — Tangier-Tetuán road, near boundary of international zone, 1926, *Ellis* (BM) —Near Tetuán, at the mouth of the river Ibn Hanesh, 1851, *Ball* (K) — Near Larache, 1930, *Font Quer* 693 (G, MAF, MPU, S) — 8 km

S of Arbaoua, W of road to Kenitra, 34º 50' N. 5º 45' W, 1974, Reading Univ/BM Exped. 56 (BM) — Rif, Above El Jebha, 1973, *Davis* 54922 (BM) — Near Targuist, 1927, *Font Quer* 692 (BM, G, MA) — Ben-Uriaguel, Zoco Tenim, 1932, *Sennen & Mauricio* 8440 (BM, G, MA, W) — Beni Uriaguel, *Sennen* (MA) — Kotbiyne, 10 km W of Tiflet on the P1 road, 1971, *Dittrich* 1112 (G) — Near Taza, 1929, *Maire* (MA) — Middle Atlas, Mrirt plain, 1923, *Maire* (MPU).

ALGERIA: Near Mascara, *Desfontaines* (G).

«Typical» *C. hystrix* s.l. (incl. *C. baetica*)

(*C. baetica*) SPAIN. **Albacete:** Riópar, 1850, *Bourgeau* 733 (G, K, P). **Cádiz:** Grazalema, 1890, *Reverchon* 379 (G) — Algar, 1919, coll. ignot. (MA) — Between Ubrique and Puerto de Galiz, 1979, *Galiano & al.* 1395/79 (MA, SEV). **Córdoba:** Between Priego de Córdoba and Carcabuey, 1971, *Varo* (GDA) — Priego de Córdoba, El Chaparral, Sierra de Horconera, 1977, *Devesa* (SEV). **Granada:** Between Málaga and Granada, 1849, herb. Reuter-Barbey (G) —Sierra Nevada, Pulche, 1851, Bourgeau 1233a (G) — Pulche, 1857, Del Campo (G); 1967, *Varo* (GDA) — Sierra Nevada, Puihe, 14-1500 m, 1879, *Huter & al.* 376 (BM, G, MPU, W) — Sierra Nevada, Puihe, 1700 m, 1891, *Porta & Rigo* 478 (BM, S, W) — El Puihe, 4000', 1848, *Funk?* (W) — Sierra Nevada, above El Puihe, 4-5000', 1848, *Funk?* (G) — Sierra Nevada, *Willkomm* 345 (BM, G, W); 1861, *Del Campo* (G) — Sierra Nevada, road, 1200 m, 1984, *Quesada & Sánchez* (GDA). **Jaén:** Near the Alcalá «pignog»?, 1840, herb. *Fauché* (G). **Málaga:** Sierra de Ronda, 1889, *Reverchon* 379 (BM, G, K, MA, MPU, S, W) — In Sierra Nevada and above Alhaurin, 1837, herb. Boissier 124 (BM, G, P, W) — Between Alama and Vélez Málaga, *Lagasca* (MA).

(*C. hystrix*) MOROCCO: Targuist, 1931, *Sennen & Mauricio* 7879 (BM, G, MAF, MPU, W) — Between Targuist and Sok-et-Tnin, Beni Hadifa (Beni Uriaguel), 1929, *Font Quer* 460 (BM, G, MA, MAF, S) — Ito, 1921, *Maire* (MPU) — Ifrane, around Biological Station, 1960, *Höpflinger* (G).

Intermediate morphs

MOROCCO: Halfway between Tangier and Tetuán, 1973, *Davis* 54700 (BM) — ± 25 km SW of Rabat, crossing of Casablanca road with Oued Yquem, 1961, *de Wilde & al.* 2328 (BM) — Oued Cherrat, 1921 *Maire* (MPU) — Immouzzer to Ifrane, 1973, *Davis* 55055 (BM) — 30 miles S of Meknes on route to Azrou, 1968, *Goodchild* 21 (BM) — Ain Kahia, c. 12 km SE of Ain Leu, 1968-1969, *Deag* 41 (BM) — Timhadit, 1924, *Jahandiez* 896 (BM, G, MA, MPU) — Tinisiourine, 15 km WSW of Timhadit, 33º10' N, 5º12' W, 1975, *Crane* (Reading Univ. Biological Expedition 67) (BM) — Asilal, 1927, *Jahandiez* 326 (G) — Beni Mellal Province, near Azilal, S of Beni Mellal, 1966, *R. & A. Harley* 675 (BM) — Demnat, 1936, *Balls* B3025 (BM, S) — High Atlas, Reraia, near Tanahaout, dry slopes, 1922, *de Litardière* (G) — Reraya, near Tahanaout, rocky hills, *Maire* (MPU) — Asni, 1936, *Balls* B3144 (BM, G, K, S).

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REFERENCES

Davis, P. H. & Heywood, V. H. —1973— Principles of Angiosperm Taxonomy — Huntington, New York. Robert E. Krieger Publishing Company.

Fernandes, A. & Queirós, M. —1971— Contribution a la connaissance cytotaxinomique des Spermatophyta du Portugal. II Compositae — Bol. Soc. Brot. 45 (2): 5-122.

Heiser, C. B. (Jr.) —1973— Introgression re-examined — Bot. Rev. Lancaster. 39: 347-366.

Holmgren, K., Kauken, W. & Schofield, K. —1981— Index herbariorum, I — The herbaria of the world, 7th ed. Utrecht/Antwerpen. Bohn, Scheltema & Holkema (Regn. Veg. 106).

Talavera, S. —1981— Números cromosómicos para la flora española, 182-256 — Lagascalia 10 (2): 225-256.

Talavera, S. —1987— Cynara, In: Valdés, B., Talavera, S. & Fernández-Galiano, E. (eds.) — 1987— Flora vascular de Andalucía occidental, 3. Barcelona, Ketres Editora, S. A.

Wiklund, A. —1985— The genus Asteriscus (Asteraceae-Inuleae) — Nord. J. Bot. 5: 299-314.