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TAXONOMY AND EVOLUTION OF *SENNA OBTUSIFOLIA* AND *S. TORA*

B.R. Randell

State Herbarium, Botanic Gardens, North Terrace, Adelaide, South Australia 5000

Abstract

The relationship between *S. obtusifolia* (L.)Irwin & Barneby and *S. tora* (L.)Roxb. is discussed. Consideration of biogeography suggests that the latter species evolved in Asia from the former.

Taxonomy

Both *S. obtusifolia* and *S. tora* are weedy in northern Australia and many other areas in Asia and the Pacific. Their relationship has become an important facet of a project to investigate biological agents for their control.

It is universally acknowledged that the taxa are very closely related, with strong similarities in gross morphology (Brenan 1958, De Wit 1955, Randell 1988), ecological requirements (Ablin 1990), and seed chemistry (Randell unpubl.). The constant differences between them are few and relatively minor, involving seed and anther morphology (De Wit 1955, Brenan 1958, Randell 1988), seed weight (Randell unpubl.), vegetative characters (Singh 1968), and epidermal features (Mathur 1985, cited in Vatsavaya & Rama Rao 1986).

S. obtusifolia is commonly, perhaps always, self-pollinated before the flower opens (Irwin & Barneby 1982). The two forms are not known to hybridise in the field (Randell unpubl.) but are interfertile in experimental crosses (Irwin & Turner 1960). There is a suggestion that they flower at different times (Vatsavaya S. Raju & N. Rama Rao 1986).

Taxonomically, there are 3 possible ways to describe the relationship between the two forms.

1. They are the same species (e.g. Bentham 1871, Irwin & Barneby 1982).
2. They are different species (e.g. Linnaeus 1753, De Wit 1955, Randell 1988).
3. They are infraspecific taxa within the same species (Haines 1922).

It may be significant that, virtually without exception, those who placed the names in synonymy worked in America or Europe, where only herbarium material was available. Workers in Asia, with access to living material, uniformly maintained that two taxa of at least varietal level were involved. However, all these judgements were based solely on morphological evidence.

Evolution of the taxa

In evolutionary terms, the very close relationship between the taxa could be explained in several ways; viz. 1. *S. obtusifolia* may have evolved from *S. tora*; 2. *S. tora* may have evolved from *S. obtusifolia*; or 3. both taxa may have evolved from a common ancestor.

Consideration of the biogeography of the two taxa may help decide which is the most likely hypothesis.

Currently, *C. tora* occurs on the Indian continent (Vatsavaya & Rama Rao 1986); in Thailand (Smitinand *et al.* 1984); New Guinea (Verdcourt 1979); Malaysia (De Wit 1955); Java (Backer & van den Brink 1963); and (rarely) in Australia [Pt Darwin, N.T., 1888; Milla Milla, Qld, 1952 (Randell 1988)].

C. obtusifolia is distributed in India (Singh 1968); Philippines (Irwin & Barneby 1982: 254); more rarely in Java (Backer & van den Brink 1963) and New Guinea (Verdcourt 1979); it is common in the southern United States north to North Carolina and Missouri (Isley 1975); through Mexico and Central America, circum-Carribean; in South America from Colombia through Brazil to Paraguay and Argentina (Irwin & Barneby 1982: 253); and also from "Uganda, Kenya, Tanganyika and Zanzibar" in Africa (Brenan 1958).

However, this detailing of the current distribution gives no indication of the original boundaries of distribution, nor of how much of the current situation is due to human activity. For example, it is known that *S. obtusifolia* has reached Australia only in recent years, but it is now becoming alarmingly common in coastal areas of north Queensland, around Cooktown, Cairns and Mackay (Ablin 1990).

Both species are placed in the South American series *Trigonelloideae*, a group of 9 species, of which 7 are restricted to the Americas, one (*S. obtusifolia*) is very widespread and almost pantropical, and one (*S. tora*) is extra-American in distribution (Irwin & Barneby 1982, though *S. tora* is not covered in this revision).

Within the series, *S. obtusifolia* is part of a closely related group also including the weedy *S. cobanense* and the rare and localised *S. pentagonia*, which "probably originated by mutation from the common sickle-pod (i.e. *S. obtusifolia*) or an immediate ancestor" (Irwin & Barneby 1982: 256).

S. obtusifolia occurs in the core distribution area of the series (South America). It is "phenetically heterogenous" with three chromosome races (n=12, 13, 14) (Irwin & Barnby 1982). It shows a variety of inherited growth forms (Irwin & Turner 1960). Its seed germination is tolerant of a wide range of temperatures (Singh 1968). Thus *S. obtusifolia* is a variable taxon, and it is not unlikely that it has given/will give rise to further new forms.

S. tora occurs outside the core distribution area of the series (i.e. from India, to China and the Philippines). Phytochemical studies have shown that compounds present in *S. obtusifolia* are absent in *S. tora* (Upadhyaye & Singh 1986, cited in Ablin 1990). It shows a narrower tolerance for variation in seed storage temperatures (Singh 1968). These descriptions all refer to a relatively stable taxon.

Thus it is very unlikely that *S. tora*, relatively invariable and outside the core distribution area, gave rise to *S. obtusifolia*, highly variable and within the core distribution area. Hypothesis 1 can be discarded.

So it is probably that *S. tora*, like *S. cobanense* and *S. pentagonia*, evolved from *S. obtusifolia* or from an *S. -obtusifolia*-like ancestor.

There was probably a common ancestor of *S. obtusifolia* and the other 7 taxa currently occurring in South America. However, there is no evidence that any such taxon ever existed outside South America.

If *S. tora* had evolved in Central America, we would expect to find records of its occurrence in either America or Africa. Irwin & Barneby (1982: 254) confirm that it is "foreign to the New World", and Brenan cites only a single doubtful specimen of *S. tora* from Africa (1958: 251). Its absence from both those areas indicates that it probably evolved in Asia.

It would then be impossible for *S. tora* to evolve in Asia, from an *S. obtusifolia-like* ancestor which never occurred outside South America. Hypothesis 3 becomes very improbable.

Could *S. tora* have evolved in Asia from *S. obtusifolia*? (hypothesis 2). This is certainly possible.

Senna obtusifolia does occur in areas where *S. tora* is distributed i.e. in India and southern Asia. The first record of the occurrence of *S. obtusifolia* in India is that of Roxburgh (1832 as *S. toroides*), who reported seeds of the plant being collected in Mysore in 1800. Apparently, the first collection of true *S. tora* was made in Sri Lanka by Paul Hermann, definitely before 1695 (his death) and probably before 1680 (when he took up a professorial chair in Europe) (Stafleu & Cowan 1979).

Then the most probable of our three hypotheses is that *S. tora* evolved in Asia from plants of *S. obtusifolia*. Perhaps *S. tora* is a race of *S. obtusifolia* that was produced by a rare mutational event, and, if both are self-pollinated, is reproductively isolated from its parent.

Irwin & Barneby (1982) recognise that *S. obtusifolia* is not uniform. It may be possible to determine which variant of it gave rise to the taxon now known as *S. tora*.

There are two major variants of *S. obtusifolia* in the Americas, differing primarily in pod type. Plants from "the Antilles and the United States" have broader pods, 3.5–6 mm in diameter, as do African specimens, and those from India, Indo Malaya and China (Irwin & Barneby 1982: 254). It seems likely that material of this variant was transported from the Americas to Africa and thence to Asia. Irwin & Barneby also discuss this possible expansion.

Conversely in most other areas of South America, the pod is narrower (2–3.5 mm diam.) and strongly curved. Populations in the Philippines are of this type, and probably represent a separate later introduction of the narrow-podded variant, (Irwin & Barneby 1982) perhaps from the west coast of Mexico.

Indian workers diligently searching for characters useful in distinguishing the two taxa have never mentioned pod width. We may then infer that *S. tora* strongly resembles the Indian populations of *S. obtusifolia* in pod diameter. *S. tora* is generally described as having pod diameters of 5 mm (Smitiland *et al.* 1984 for Thailand; De Wit 1955 for Malaysia) 4–6 mm (Symon 1966 for Australia) or 2–5 mm (Randell 1988 for Australia). Thus it is probable that it was derived from an ancestor like the broad-podded form of *S. obtusifolia* from "the Antilles and the United States."

Biological studies (e.g. enzyme analyses or DNA studies) are needed, to confirm the suggestion that *S. tora* is derived from the broad-podded variant of *S. obtusifolia*.

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