Aboriginal Fish Poisons and the Diffusion Problem[1]

CARROLL QUIGLEY
Georgetown University

RECENT work on the world-wide distribution of aboriginal fish poisons has indicated that the New World forms a single diffusion area, spreading outward from a focus in northern South America (Heizer 1953:255); that there has been no diffusion from the Old World to the New (p. 257); and that the Old World may be either a single diffusion area or may fall into the three separate diffusion areas of Europe, Africa, and Asia with Oceania and Australia (pp. 249, 256). In this paper I hope to show that the Old World may be regarded as a single diffusion area, and that the independence between the New World and the Old in this matter is not conclusive.

In such an analysis we must make an essential distinction between diffusion of the knowledge that plant juices can stupefy fish, and diffusion of particular plants or particular methods of extracting these juices. There can be no doubt that the former would diffuse more easily and more rapidly than the latter. Moreover, recognition that plant juices can stupefy fish is not a discovery which would appear to be made easily but must have resulted from some accidental occurrence of the phenomenon, followed by meditation on it, and recognition of the connection. This seems so much more difficult than diffusion of the knowledge itself that it is only fair to assume that the presence of the trait in two areas which are known, from other evidence, to have had cultural connections should be attributed to diffusion rather than independent discovery, even if the two areas use different plants as piscicides. Finally, if such areas use the same plants, it would seem conclusive that occurrence of the trait results from diffusion and not from independent discovery.

The use of these principles in interpreting the factual material provided by Heizer, with the addition of a small amount of material which he does not mention, seems to support the impression that the Old World forms a single diffusion area. Heizer himself did not reach this conclusion, probably because of the complexity of the botanical evidence and also because of his reluctance to use diffusion over sea routes. For example, he doubts diffusion of the trait from the Levant to Greece because of its rarity in Anatolia (the land-link between the two areas), but does not mention the fact that Asia and Europe used the same plants (*Anamirta cocculus* and *Verbascum sinuatum*) for fish poisons. As we shall show later, these plants could have been carried by ship from Syria to Greece without stopping in Anatolia at all. Like most Americanists, Heizer is very sceptical of the possibility of prehistoric navigation across water distances beyond the range of vision. Old World prehistorians do not share this reluctance because they have extensive evidence for navigation even earlier than 2000 B.C. Islands of the Old World were clearly settled at very remote periods across deep water, and cultural links can be found across such waters millennia ago. There are numerous examples of this in the Indian

Ocean; a less well-known one is the diffusion of agriculture from Spain to Britain by sea between 2500 and 2000 B.C. and the later construction of an earth-mound (passage-grave) on St. Kilda, fifty miles west of the Outer Hebrides (Hawkes 1947:42–47). The original inhabitants of the Mediterranean islands, especially Crete, must have settled on them at a fairly remote period, at least before 4000 B.C. (Pendlebury 1939:35–41; Hawkes 1940:77; Childe 1949:18, 22, 41). And the earliest inhabitants of Japan must have arrived by boat in the early Holocene, perhaps shortly after 5000 B.C. (Groot 1951:4, 11).

It is worthy of note that Heizer makes the New World, with whose prehistoric materials he is most familiar, into a single diffusion area, and does not hesitate to use rather lengthy water-crossings in doing so (for example, from South America to southeastern United States via the Antilles; p. 254). On the other hand, he displays no such confidence in his discussion of the Old World evidence. To be sure, he is willing to include Australia and Oceania in a single Asian diffusion area, but is much less willing to include Africa or Europe in the same area.

In view of the widely accepted theory that Oceanian cultural origins are largely Asiatic, there is little problem in linking that area to Asia (Heizer 1953:246). On turning to Australia, Heizer argues convincingly against the conclusion of Hamlyn-Harris and Smith that the practice of fish poisoning in Australia was of independent origin, pointing out (ibid. pp. 243–244), "Two facts must be noted which have a bearing upon this conclusion. The first is the continuous Australian distribution of fish drugging; the second is the decided emphasis on fish stupefying in the region adjoining Melanesia, the same area in which, in other aspects of culture, the most pronounced external cultural influence has been received, viz., Queensland . . . The concept of fish drugging may have entered Australia ultimately from Southeast Asia via Malaysia and western Melanesia. It was first received by the Queensland natives on Cape York Peninsula, where the center of development is noted." This argument for diffusion would have been strengthened if Heizer had pointed out that several of the plants used in Queensland (*Barringtonia asiatica, Tephrosia purpurea,* and *Derris uliginosa*) were the same plants used for this purpose in the East Indies. In fact, many plants are so widely used as piscicides in the Old World that the argument for diffusion of this trait, rather than for several independent discoveries, is greatly strengthened by examination of the botanical evidence. Heizer's detailed areal lists of piscicides offer a convenient way of doing this. On these lists, however, the case for diffusion has occasionally been weakened by the use of different names for the same plant in different areas. For example, *Derris uliginosa* and *Derris trifoliata* are the same plant (Kelsey 1942:159); so too are *Barringtonia asiatica* and *Barringtonia speciosa* (Kelsey 1942:42), while *Anamirta cocculus* and *Anamirta paniculata* are the same plant, since this is a monospecific genus (Willis 1931:35). Heizer also lists this plant under a third name, *Cocculus indicus,* from Java (1953: 261). Also, certain omissions from these lists (such as *Mundulea suberosa* from

Central Africa, Madagascar, India, and Ceylon (Howes 1930:33) may or may not be significant.[2]

If we examine Heizer's lists with these corrections in mind, it is clear that a few species of plants were used as fish poisons over wide areas in the Old World. *Barringtonia asiatica* was used from Madagascar to Tahiti, including en route the Nicobar Islands, Celebes, Philippines, the Marianas, New Britain, Solomon Islands, Queensland, Fiji, Samoa, and most of Polynesia (including Tahiti and the Marquesas). Since *Barringtonia* is a littoral plant disseminated by water-borne seed, this wide distribution of the species has no significance as evidence of diffusion by human agency. Another plant, *Derris uliginosa*, is used as a fish poison from the Zambezi River in Africa, through India and Southeast Asia to the Philippines, Java, Australia, Fiji, and the Marquesas. This distribution is much more indicative of a possible human role in its dissemination because *Derris*, when used as a fish poison, is commonly a cultivated plant and may have been spread over some of its broad range by human action. A third fish poison, *Mundulea suberosa*, "probably as a result of age-long cultivation" (Howes 1930:133) is used throughout tropical Africa as well as in Madagascar, India, and Ceylon. Or again, *Anamirta cocculus* is reported from Brittany to the Philippines, including Palestine, Arabia, Persia, India, Malaya, and Java. Another widely distributed plant used in the same way is *Derris elliptica*, reported from India, Malaya, Indonesia, Borneo, Philippines, the Caroline Islands, and New Guinea.[3] As we shall see later when we examine the thorny problems of the genera Lonchocarpus and Tephrosia, other species used as fish poisons were distributed even more widely. In general, the wide distribution of a few plants used in the same way over an area which is known to have been in culture contact from a remote period of prehistory seems to strengthen the view that the whole Old World forms a single diffusion area.

This idea of the Old World as a single diffusion area is reinforced when we review the evidence for diffusion across the hypothetical boundaries which roused Heizer's doubts; these were the boundaries between Asia and Africa, and between Asia and Europe. In regard to the former, Heizer says (1953:247) "There is no concrete evidence of origins in Africa, but . . . the distribution ([Heizer's] map 2) suggests the possibility of an independent African origin of fish drugging . . . African fish poisoning may be a tropical West African invention, later diffused generally throughout the continent. Or it may have been anciently related to the Euro-Asian occurrences, the former intermediate links not now being in evidence." The last sentence refers to the lack of the trait in Egypt and the Sahara, and shows Heizer's assumption that any African connection with Asia must have been by the land-bridge at Suez. Other evidence, with some of which Heizer is familiar, shows clearly that southeastern and eastern Africa have been in cultural contact with Asia by sea throughout history and far back into the prehistoric period. As Heizer says (1953:247), "Madagascar has experienced profound cultural influences from the Malaysian area." That fish poisoning may have been among these cultural influences is certainly indicated by the fact that southeast Africa shared several poisoning plants with southern Asia (*Derris uliginosa, Mundulea suberosa, Barringtonia asiatica, Tephrosia purpurea,* and *Tephrosia vogelii*). The direction of the prevailing winds and ocean currents, coming from the southern and southeastern coasts of Asia down to Madagascar, made it inevitable that early seafarers from these coasts would eventually reach the island (Hornell 1934). Most recent writers on the subject, such as Grandidier, Ferrand (1919, 1934), and Linton, have been struck by the evidence of Malayan influence in Madagascar, while Danielli has traced such influences to even more distant areas in East Asia and Europe. It is an interesting fact that the Negritos, the most widespread and possibly the most ancient peoples of this whole circum-Indian Ocean area, are very familiar with plant poisons and must have reached some of their present habitats by sea. This is true, for example, of the Andaman Islanders (Radcliffe-Brown 1948:5, 417), and was probably true of the original settlers of Madagascar if these were Negritos, as Ferrand believed (1936:74). In any case, the cultural links between Malaysia and Madagascar are beyond question. In the same way, there have been links by sea between southeastern Africa and southwestern Asia. In historic times these links have been so strong that for long periods Zanzibar and parts of Arabia (Oman) have been under the same political control (Coupland 1938; Salil ibn Razik 1871). Several recent writers have argued from the distribution of birds, flora, and human evidence that the tropical jungles of Central Africa and those of South Asia must have been linked in the prehistoric period by tropical forest conditions in southern Arabia, especially in Oman (Chapin 1932; Nielsen 1927; Coon 1943). The archeological and cultural evidence supports the existence of such a link even in the most remote period (Breuil 1954). The fact that the natives of the Zambezi River and those of much of southern Asia use the same plants for fish poisoning surely does nothing to weaken this link. Nor is this theory of an Asiatic origin weakened, as Heizer believed, by a West African "focus" of fish poisoning. This West African focus is an "ecological focus" rather than an "origin focus." Like northeastern South America and southeastern Asia, West Africa had those tropical rainforest conditions which produced numerous piscicide plants and which permitted the trait to flourish because of the existence of constant streams, warm water, rapid reproduction of fish, and so forth. The fact that there are three tropical rainforest areas and three foci of fish poisoning associated with them indicates that the trait flourishes under tropical rainforest conditions, not that it originated in any one of the areas rather than another. Indeed, the fact that cultural diffusion in Africa seems generally to have been southward and westward rather than eastward or northward (and thus into West Africa rather than out of it), combined with the evidence that southeast Africa is part of the Asiatic cultural (and fish poisoning) diffusion area, makes it very unlikely that West Africa is an "origin focus" rather than an "ecological focus."

The absence of the fish poisoning trait from Egypt and the Sudan is no insuperable obstacle to the inclusion of Africa in the Euro-Asian diffusion area. As Heizer recognized (p. 247), the present desiccation of North Africa may well have destroyed evidence that the trait existed in an earlier period when that area was more plentifully watered. This is particularly true when we find fish poisoning reported from the Canary Islands (Cook 1900:466) in a cultural context which is very largely North African. Moreover, Egypt, like Anatolia, may be an example of another characteristic of piscicides. It seems evident that fish poisoning tends to disappear in areas of higher civilizations and strong governments. This tendency is pointed out by Howes in general terms (1930:129), by Killip and Smith in regard to South America (1931:407) and by Heizer (1953:241–249) in regard to Europe. If this is a valid rule it could surely be expected to apply to Egypt, where civilization and strong government go back to 3000 B.C. The same explanation could be used for the rarity of the trait in Anatolia, where civilization and strong government date to before 1500 B.C. (Troy and the Hittite Empire). In this connection, Plato's prohibition on fish poisoning in the fourth century B.C. is certainly significant (Heizer 1953:241, n. 36 quoting from Butler 1930:133). If we add to these arguments the fact that seaborne trade was moving westward from the Levant as early as 3000 B.C. and had reached Spain by 2700 B.C., bringing such Asiatic cultural influences as the use of metals, knowledge of agriculture, a cult of the dead, familiarity with the solar calendar, and possibly some domestic animals of tropical forest origin such as fowl, swine, or dogs (Hawkes 1940:83, 128–129, 199; Childe 1948:259–278) we can see that the modern absence of widespread fish poisoning in Anatolia is no obstacle to the inclusion of Europe in the Asiatic diffusion area of the trait. The fact that the most commonly used fish poison plant in Mediterranean Europe was the same plant (*Verbascum sinuatum*) which was used in Palestine and Syria also strengthens the arguments in support of a single Euro-Asian diffusion area. The theory that fish-poisoning may have been diffused from Asia to Europe by sea is supported by a piece of evidence whose significance might be lost on anyone who lacked a considerable knowledge of European prehistory. The seaborne megalithic influences which brought a knowledge of metals and agriculture and a cult of the dead associated with megalithic monuments to Spain about 2700 B.C. and to Britain about 2300 B.C. established their main Western European focus in Brittany (Daniel 1941). This focus is still marked by numerous megalithic monuments on the southern coast of the peninsula, and may also be marked by the fact that as late as 1884 (Anon. 1884) the Bretons used as fish poison a plant (*Anamirta cocculus*) of South Asiatic origin (Willis 1931:35; Howes 1930:138) whose chief usage for this purpose was in the area from Suez to Bengal.

From these arguments, it would seem very likely that the entire Old World area possessing this trait formed a single diffusion area, with its origin somewhere in southern or southeastern Asia, whence the trait diffused eastward to Indonesia, Australia, and Oceania, southwestward to Africa, and westward to Europe, but did not go northward to northeastern Europe or northern Asia.

The fact that this trait is generally unrecorded in northern Asia and is not found on either side of Bering Strait as far south as Japan in Asia or as the

Columbia River in America, does not preclude the possibility of diffusion from the Old World to the New. The evidence seems clearly to show that the fish poisoning trait did not come to the New World by way of Bering Strait. On the other hand, the possibility has been opened in recent years that it may have crossed the Atlantic from Africa. Since this is no place to examine the total evidence for such a possibility, I shall limit my remarks to two kinds. Ocean currents and winds are such that a voyage from West Africa to South America would have been the easiest transoceanic voyage in prehistoric times, with a distance about one-quarter or one-fifth the trans-Pacific distance and a sailing time only a fraction as long as any other transoceanic route. Moreover, the winds and currents (which are such as to make a forty-five day voyage a distinct possibility even in a primitive craft with rudimentary sails) lead directly from the fish-poisoning "focus" of West Africa to the similar "focus" of northwestern South America. Finally, there is the growing evidence that such a connection may have occurred. Leaving aside the controversial problem of the paleo-Indian or of African physical types in jungle South America, we should turn our attention to the cultural evidence. It seems evident that the fish-poisoning technique is of tropical forest origin and appeared in a cultural context which included emphasis on poisons and fibers, the use of fish-nets, gourd-floats, and stone-sinkers, with an elaborate knowledge of botanical poisons, stimulants, and narcotics, probably the poisoned arrow and possibly the blow-gun, the practice of a rudimentary agriculture which concentrated on fibrous plants and root crops propagated by vegetative cuttings, and possession of the dog, fowl, and swine as domestic animals. With the exception of swine, all of these elements are found in a similar context in West Africa and jungle South America. The recent evidence (as in Carter 1953 or Sauer 1952) that both sides of the South Atlantic had the same species of gourd, cotton, and black-fleshed, tailless jungle-fowl, and the evidence (as in Bird 1948) that the earliest American agriculture (perhaps as old as 2500 B.C.) grew gourds and cotton in a fishing economy, make it necessary to consider the possibility of a cultural diffusion, including piscicides, across the South Atlantic from Africa to South America. This is not the place to attempt such a task, and I shall restrict my consideration to piscicide plants. It is obvious that under such a restriction nothing conclusive can be demonstrated, but it can be shown that absence of this trait from the Bering Strait area does not provide conclusive proof for its independent invention in the New World.

The most widely used piscicides are members of the botanical family *Leguminosae*. This numerous class is sometimes (as by Chevalier 1937b:565) divided into the two tribes *Dalbergiae* and *Galegeae*. The *Dalbergiae* include the genera *Dalbergia*, *Derris*, *Lonchocarpus*, *Piscidia*, and *Cadia*, while the *Galegeae* include *Millettia*, *Tephrosia*, and *Mundulea*. Auguste Chevalier, who spent years studying these plants, says (ibid.) "Ces deux tribus (ainsi que certains genres qu'elles renferment) sont du reste mal delimitées: ainsi on passe insensibilement des *Lonchocarpus* aux *Millettia*." Generic differences are even more weakly defined. A recent writer, the botanist Schery, says (1952:295)

"In the Far East the counterpart of *Lonchocarpus* is *Derris* (tuba) also of the *Leguminosae*. Even the foremost taxonomists have been hard put to find any significant differences between these two genera, other than their geographical distribution, one being found in the New World and the other in the Old." Roark (1938) quotes J. Lindley (1876) as saying that *Lonchocarpus* could be distinguished from *Piscidia* and other allied genera only by the shape of its fruit pods since the flowers were the same, while Grandidier (1902:XXX, p. 288) said that in Madagascar *Lonchocarpus* could not be distinguished from *Milletia*, except when it had mature fruit. Similarly, *Tephrosia* is distinguished from *Mundulea* only by the shape of the calyx, and the latter is distinguished from *Milletia* by similar small differences. As a consequence, there is widespread disagreement between botanists as to the genus of many plants, and even greater disagreement when efforts are made to put these plants into species. Worsley, after studying *Mundulea suberosa*, a fish poison used from Africa to Oceania, accused Chevalier of confusing *Mundulea suberosa* with *Tephrosia vogelii* (Worsley 1936:312) and was contradicted on grounds of personal knowledge (Chevalier 1937a:24, n. 1). The *Mundulea sericea* of Willdenow is the same plant as the *Tephrosia sericea* and the *Tephrosia suberosa* of De Candolle (according to Chevalier 1937a:21), while the Madagascan fish poisoning plant which Baker called *Tephrosia monantha* is called *Mundulea endemica* by Edouard Heckel. Similar examples could be quoted by the score.

When we turn from generic distinctions to species differences the confusion becomes even greater. We shall examine from this basis the two groups *Lonchocarpus-Derris* and *Tephrosia* because of their great significance in the whole problem of fish-poisoning, the origins of agriculture, and early human migrations.

In the Old World a number of widely used piscicides fall into the genus *Derris*, and are used over an area extending from West Africa eastward to the Marquesas. In the New World a somewhat similar position is held by a number of plants which are usually classified in the genus *Lonchocarpus*. As we have said, botanists have been unable to establish any distinctive differences between these two genera, and it seems evident that they may eventually be placed in a single genus. Efforts to base some generic distinction on the size or shape of the seed pods have been without much success because the pods vary so greatly even on the same plant, but above all because many *Lonchocarpi* produce neither blossoms nor seeds (Roark 1938:13–16; Krukoff and Smith 1937:575; Martyn and Follett-Smith 1936:157; Chevalier 1937b:578–582; Hermann 1948:72–75). This problem did not become acute until about 1930, when it was discovered that some varieties produce rotenone which could be used as an insecticide. Until then, varieties found in South America were generally put into *Lonchocarpus* while those found in Asia were put into *Derris*, but as botanical knowledge of Africa increased, a problem arose. Some varieties were put into one genus while other similar ones were put into the other genus. About twenty years ago this confusion spread into South America. A plant from Surinam, which Miquel in 1844 had called

Lonchocarpus pterocarpus, was identified by Killip as the *Derris pterocarpus* of De Candolle. The *Lonchocarpus negrensis* of George Bentham became Killip's *Derris amazonica*. These changes were not caused by any twentieth century revulsion against the ideas of the nineteenth century, but by the complexity of the botanical problem. In fact, even in the nineteenth century, Bentham had put some South American varieties into the genus Derris (i.e. *Derris guyanensis*). Where botanists cannot establish order it is wise for non-botanists to stay out, but it seems to be agreed that the confusion and instability is on the New World side of the Atlantic. Clearly, *Lonchocarpus* presents a botanical puzzle. There is a very large number of species (120, according to Willis 1931:392), but the individual plants are so variable and species distinctions fluctuate so widely that the establishment of botanical order is no small problem. There is considerable doubt whether the most commonly used piscicide *Lonchocarpi* are ever found wild (except as feral individuals), and there are disputes as to whether they normally bear blossoms or seeds. It is quite certain that many of the plants of this genus found in the American tropics result from human activity, planted by the vegetative method. As Heizer realizes (1953:255), a situation such as this indicates a long period of human cultivation of these plants in the New World, with its resulting local variation and inconstancy of characters. Unfortunately, most of the efforts made toward botanical classification of *Lonchocarpus* have been based on obvious external characters rather than on any genetical approach (which may be impossible; Senn 1938 has nothing on either Derris or Lonchocarpus).

There have been four main efforts to classify *Lonchocarpus:* by George Bentham (1860; 1862); by Henri Pittier (1917); by B. A. Krukoff and A. C. Smith (1937); and by Frederick J. Hermann (1947–1948). All except Bentham's were restricted geographically, either to the New World or to Middle America. Even on that basis it cannot be said that these efforts have been successful. Each writer has merely rearranged the confusion, collapsing species established by earlier writers and creating new ones of his own. Not only do individual plants of different species closely resemble each other in obvious characters such as habits or leaves, but these characters vary with conditions. Leaves, for example, differ between old plants and young ones, between upper and lower branches; they differ when growing in shadow or in sun, in humid spots or in drier ones. Thus the leaves on the same plant may be different, while the leaves on a neighboring plant of a different species may be the same (as is true, according to Krukoff and Smith 1937, p. 522, of the leaves of *Lonchocarpus utilis* A. C. Smith and the middle leaves of *L. nicou* Killip and Smith grown in the shade). The same fish-poisoning plant, depending on conditions, may be a bush, a climbing vine, or a small tree, and may or may not be an effective piscicide. In a similar way (according to Panshin 1937) the wood anatomy of the same plant varies as greatly as the differences between species. As in most fish-poisoning plants, especially cultivated ones, the toxic content varies so greatly that a plant which is effective in one locality or at a certain season of the year may be innocuous in a different locality or season. There is considerable evidence that many of these variable characters, including toxicity, are heritable. In a series of studies recorded by Jones, it was found that the rotenone content of *Derris elliptica* varied from 0 percent to 6.9 percent, while that of *Lonchocarpus nicou* varied from 4 percent to 11.2 percent (Jones 1933).

The older, accepted distinction between species and varieties was that species possessed stable and constant characters which did not intergrade, while varieties had variable, inconstant, characters which intergraded, usually on an areal basis (Biological Society of Washington 1919; Clausen et al. 1939; Ripley 1945). These rules do not hold for the leguminous piscicides; in fact, they do not hold for weeds, cultivated varieties, or feral plants (Anderson 1952:16–48). Man is so disruptive to natural ecology that all kinds of unnatural botanical varieties can survive where he has passed. He moves about so rapidly and carries with him so many different plants, either unconsciously as weeds or consciously as cultigens, that he completely disrupts geographic intergradation, with the result that taxonomists are constantly tempted to classify as new species (and thus run up their own score of such innovations) what are basically only varieties. This temptation is increased when an ocean intervenes between two varieties. Plants which would hardly merit varietal differentiation if found on the opposite banks of a river will readily earn special (or even generic) differentiation if they are on opposite shores of an ocean, and will do so on nonbotanical grounds. Botanists generally assume that there was no transoceanic interchange of plants before 1492, and create new species on that assumption alone. Finally, the temptation to create new species reaches its peak when we are concerned with cultivated plants propagated by vegetative methods, especially when these methods have practically eliminated the possibility of obtaining blossoms or fruits. All of these problems apply to the leguminous piscicides and especially to *Lonchocarpus*. After years of study and several expeditions into the jungle, examining thousands of plants at all seasons of the year and utilizing the resources of Kew Gardens, the New York Botanical Garden, the U. S. National Herbarium, and the University of Utrecht Herbarium, Krukoff and Smith were able to identify 10 kinds of *Lonchocarpus* or *Derris* in South America, but had fruits for only five and flowers for only seven. They decided that they had three new species, six old species, a *Lonchocarpus* for which they could not determine the species, and a plant for which they could not determine the genus. In the same year in which Krukoff and Smith published the results of their study, Chevalier protested against the tendency to make new species out of varietal differences, pointing out on the basis of his studies of the collections in Paris (1937b:578–582) that he felt that *Lonchocarpus nicou* DC., *L. floribundus* Benth., *L. spruceanis* Benth., *L. rubiginosus* Benth., and *L. rufescens* Benth., should form a single species. In his study published in 1947–1948, Frederick J. Hermann moved eight *Lonchocarpi* to other genera (6 to *Willardia,* 1 to *Vatairea,* and 1 to a new monospecific genus *Terua* "intermediary between *Galegae* and *Dalbergiae* with striking mimicry of *Lonchocarpus* and very close to *Willardia*"), reduced 13 species of *Lonchocarpi* to varietal status, but created five new species in the genus (one taken from *Piscidia*).

Similar confusion exists with respect to the other leguminous piscicides, especially *Tephrosia*. No general study of this genus has been made since De Candolle's in 1825, but a number of regional studies have been made since 1920. These have been so unsatisfactory that Carroll E. Wood, Jr. wrote in 1949, "The high percentage of misidentified specimens in herbaria and the confusion in anthropological, ethnological, and chemical literature in connection with the use of various species of Tephrosia as fish-poisons and insecticides are further indications of the desirability of re-examination of the genus" (Wood 1949:193). In his efforts to bring order into the American *Tephrosia*, Wood divided them into two groups, one with glabrous styles and the other with bearded styles, and decided that it was impossible to unscramble the former group on the basis of existing information. His study of the barbistyled species reduced the number of such species in America from 90 to 45 (of which 7 were new), and reduced Rydberg's total of 72 species of all *Tephrosia* in North America and the West Indies to no more than 50. In a similar fashion, Forbes in 1948 listed 67 species in South Africa compared to Baker's 146 species from a larger geographic area in 1926 ("many of which were based on variable pubescence-characters:" Wood 1949).

The confusion in the genus *Tephrosia* is of great significance to our problem because *Tephrosia* is the most widely used genus of fish poisoning plants, and one of its species, *Tephrosia purpurea*, is pantropical. Of this species Chevalier says (1937a:17), "C'est une ubiquiste des regions tropicales. On la trouve non seulement sur les trois continents (Asie, Afrique, Amerique) mais aussi en Australie, à Madagascar, aux Philippines, et dans presque toutes les îles du Pacifique. Il n'est pas douteux qu'elle a été disseminée par l'homme primitif au cours de ses nombreuses migrations mais il est difficile de dire quelle est sa patrie d'origine."

The wide range (and even world-wide range) of some species of *Tephrosia*, their weed-like qualities (such as prevalence around old human habitats, travelling with men as hitch-hikers, etc.) their great variability, their occurrence as cultivated plants on very primitive levels and especially as cultigens whose wild ancestors are rare or lacking, and their wide use for such a primitive activity as fish poisoning, all serve to make *Tephrosia* an important plant in the study of early agriculture, prehistoric migrations, and cultural diffusion.

The genus *Tephrosia* is generally credited with about 150 species; of these (according to Roark 1937), twenty-two were used as fish-poisons. But when we examine Roark's list of these twenty-two species, it becomes clear that many are either the same species with different names or at best are varieties of a single species. For example, *Tephrosia brevipes* Benth. is the same plant as *Tephrosia sessiliflora* (Poir.). Hassl. (Killip and Smith 1935); so also, *Tephrosia densiflora* Hook. f. of Nigeria and *Tephrosia periculosa* Baker of East Africa and Madagascar are merely local varieties or the same plant as the widely spread *Tephrosia vogelii* Hook. f. (Chevalier 1937a:19–20). Wilbraux believes that *Tephrosia cinerea* (L.) Pers. is the same species as *Tephrosia toxicaria* (Sw.) Pers., which is merely the customary American designation for *Tephrosia sinapou* Buchoz (Wilbraux 1935:17), but this is rejected by Wood and others and may arise from the extraordinary confusion between these two which was pointed out by Chevalier (1937a:15). On the other hand, Wood's questioning of the pantropical status of *Tephrosia purpurea* (L.) Pers., a species excluded from his own study, and his listing of it as an exotic in America do not stand on firm ground. It has been recorded, apparently as an aboriginal plant and sometimes under the name *Tephrosia piscatoria* Pers., from the Old World, the New World, and the Pacific Islands (Chevalier 1937a:17–18; Wilbraux 1935:9; Roark 1937:35; Stokes 1921:226, 229 quoting Asa Gray 1854:XV, 407; Chopra 1941:895, not used as piscicide; Howes 1930:130–144; Virot 1950:88, not used as piscicide; Kew Royal Botanic Gardens 1911:195–196; Staner and Boutique 1937:82, not used as fish poison; Hamlyn-Harris and Smith 1916:11; Moloney 1887:311, not as a piscicide). Because of its world-wide distribution, Wood does not recognize *Tephrosia purpurea* Pers. except as an introduced plant, although a competent botanist like Small reports it as a wild plant in Florida used by the Seminole Indians as a specific for nose bleed (Small 1933:708). In this connection it may be worth pointing out that *Tephrosia leptostachya* DC, which Wood seems to accept as an American plant and which Chevalier considers to be merely a variety of *Tephrosia purpurea* Pers. found in West Africa, is reported as an aboriginal fish poison from Senegambia in Africa and from Brazil (Chevalier 1937a:17; Corbett 1940:26). Another possible link between the Old World and the New may exist between the African fish poison *Tephrosia vogelii* Hook. f. and the American piscicide *Tephrosia toxicaria* (Sw.) Pers. Both are largely cultivated plants, the American one almost completely so (Wood 1949:249–255) and the African one very largely so (Wilbraux 1935:3–7; Chevalier 1937a:19). They are so closely related that earlier writers believed each had been transplanted across the ocean. F. R. de Tussac in 1808 recorded *T. toxicaria* as a piscicide in the Antilles, and guessed that it had been brought to America by Negro slaves. Eventually it became clear, largely from its lack of ability to perpetuate itself after the Carib extermination, that the plant was pre-Columbian in the West Indies (Chevalier 1937a:11–14 sums up the argument and concludes that it was a close relative of *T. vogelii* but "malgré ses affinités . . . est bien americain"). But in his early encounters with *Tephrosia vogelii* Chevalier had considered it an importation from America, an offspring of the slave trade. He wrote, "après avoir pensé qu'il était originaire d'Amérique et importé en Afrique lors de la traite des esclaves, le considerons-nous aujourd'hui comme africain." This by no means closes the issue, however. Both plants, as cultigens, are extremely variable. Each produces an emarginate variety which is frequently considered a separate species: *T. emarginata* H.B.K. in America and *T. densiflora* Hook. f. in Africa, both apparently known only as cultivated plants (Killip and Smith 1931:407; Wood 1949:247–255; Chevalier 1937a:11–14). Moreover, varieties intermediate between *T. toxicaria* and *T. vogelii* have been found, and sometimes given species status. An example is *T. talpa* S. Watson, which was found by Edward Palmer in 1886 on the same expedition on which he reported finding *Tephrosia toxicaria* as a wild plant. *T. talpa* has since been reported as a fish poison used by the Tarahumare in the same area (Bennett and Zingg 1935:170). The distribution of *Tephrosia toxicaria*, as recorded by Wood (1949:228, 249–255), shows that it must have been spread by human activity and been carried by sea. It is found in South America from Colombia to Ecuador and Peru; in Venezula, Guiana, Brazil, and Bolivia along the Amazon drainage area, in the West Indies (notably Jamaica and Hispaniola), but in Central America only in a range from Veracruz and San Luis Potosi, Mexico, south to Guatemala and Salvador, being unrecorded from there to Colombia. Wood concludes, "Throughout much of the range in South America the plant seems to be represented primarily in cultivation, and it is likely that it would not persist in many areas without continued care. . . . If the plant has been spread primarily by man in these regions in connection with its use as a fish-poison, as seems likely, it is possible that considerable selection may have taken place." We might add that the geographic distribution he records could only have been made by man and by sea.

Thus it would seem that the widespread American fish-poison *Tephrosia toxicaria* and the widespread African fish-poison *Tephrosia vogelii* could, botanically speaking, have been derived by long cultivation from a common ancestor, and have passed across the Atlantic from Africa to jungle South America in the pre-Columbian period. The hypothetical ancestor could in turn have been derived from a variety similar to *Tephrosia candida* DC., the fish poison plant of India and southern Asia. Such an interpretation is supported by a great mass of evidence, no single piece of which is entirely convincing but whose cumulative effect is rather persuasive. We might mention the general configuration of ocean currents and steady winds which link the world's three piscicide foci, the known cultural diffusion along much of that route, the evidence that Negrito or Negrito-like people seem to have followed at least part of the route at a very remote period, that they must have had some method for crossing open water (judging from their early presence in the Andaman Islands, Madagascar, and perhaps the Philippines), and that all recorded Negritos are familiar with plant poisons and usually with fish poisons. Moreover, the Old World diffusion area for piscicides with a focus in the Bengal drainage area, which I worked out originally on the basis of botanical and cultural evidence relevant to this practice, is the same diffusion area, with the same focus and routes of diffusion, which James Hornell has worked out for primitive water craft, as I discovered after my work was finished (Hornell 1946: passim).

This is not a hypothesis which can be demonstrated easily, and it can never be proved by the study of fish poisons, but the study of piscicide plants can contribute a good deal to our understanding. The chief matters on which we need information are: the genetical interrelationships of piscicide plants, especially on an intercontinental basis; some study of the movements of such plants as they spread; a study of those plants which exist in the same or closely related forms over great distances, especially pantropical and trans-Atlantic piscicide plants, to determine how and, if possible, when they spread; and finally the combination of this botanical evidence with the available evidence of human migrations and cultural diffusion as determined by nonbotanical evidence. Certainly this is no easy task.

When we turn to piscicide plants which are pantropical (or almost so) or which are known on both sides of the South Atlantic, we find a very promising field of investigation. We have already mentioned *Tephrosia leptostachya* recorded as a piscicide in Senegambia and Brazil. This may be only a variety of the pantropical *Tephrosia pupurea* L. Pers. which we have also mentioned from many tropical areas of both hemispheres (see previous citations). Because of variable toxicity this is not used as a piscicide in much of its range. It seems to be the same plant as *Tephrosia piscatoria* DC, recorded as a fish poison from the Pacific Islands, but may not be the same as *Tephrosia piscatoria* (Ait.) Pers., which Roark cites as a piscicide on a world-wide basis (Roark 1937:4). On the other hand, *Tephrosia purpurea* is so closely related to the widespread South American piscicide *Tephrosia cinerea* L. (Pers.) that some botanists (such as O. Kuntze) include both in the same species.

Pantropical plants of other genera which are recorded as piscicides in at least part of their range are *Cissampelos pareira* L. (used in the Philippine Islands and the West Indies according to Quisumbing 1947:146 and Killip and Smith 1935:14); *Sapindus saponaria* L. (Killip and Smith 1935:14); and *Entada phaseoloides* L. (used in the Philippines, India, and South Africa, according to Quisumbing 1947; Chopra 1941; and Watt and Breyer-Brandwijk 1932). More directly concerned with our problem are two plants found on both shores of the South Atlantic. These are *Lonchocarpus sericeus* (Poir.) H.B.K. and *Serjania pinnata* L. (*Paullinia pinnata* L.). The former is listed by Gerth van Wijk (1911:776) as a native of the American tropics, was listed by Pulle (1906) as a native of Dutch Guiana, and by Roig y Mesa (1929) as a common plant in Cuba. But Sir. C. A. Moloney reported this same plant as a common growth in West Africa (1887), and Kew Gardens listed it in its *Useful plants of Nigeria* in 1911. While some writers (like Chevalier) list this as a piscicide plant, I have found no convincing reports that it is so used, but its transfer across the ocean remains a puzzle. Similarly, *Paullinia pinnata* L. requires explanation. This is used as a piscicide in South America but not in Africa, possibly because it has been replaced there by more toxic species. In explaining the presence of such plants on both sides of the ocean, Chevalier's conclusion that human groups use similar plants for similar purposes on both sides of the Atlantic by "a truly marvelous genius of intuition" is not a very convincing one. It is quite true that the fish poisoning trait might have been discovered independently by an act of intuition, but it would require much more than that to produce the same species of plant on both sides of the ocean. To do that we need either a water disseminated plant capable of floating such a distance (which these plants are not), or human agency. Nor can that human agency be found in some hypothetical transfer by Portuguese sailors or Negro slaves in post-Columbian times. The violence with which slaves were seized on the African coasts and the conditions under which they were brought to America would have allowed them neither the opportunity nor the desire to fill their portmanteux with piscicide plants before they left. Nor did Portuguese or Spanish sailors have sufficient interest in this subject to lead them to discover which plants were piscicides in order to carry them either way across the ocean. Moreover, in the Spanish and Portuguese areas, which were the chief ones concerned in the earliest period, the use of piscicides was outlawed at an early date. It was forbidden by John II in Spain in 1453, by an enactment which was renewed by later rulers such as Charles I and Philip II (Wilbaux 1935:12). Similar legislation was issued for the Portuguese areas in 1565 (Chevalier 1937a:12). Admittedly, the early Iberian colonizers did move plants and crops between the New World, Africa, the Far East, and India, but these were largely food crops and were carried by government officials and priests. Neither class of traveller would have been likely to carry local plants used by the aborigines in an illegal activity which the government was seeking to extirpate, even if we can imagine that they were much interested in such things. To be sure, it will not be easy to prove that the use of any specified piscicide plant goes back to pre-Columbian times on either side of the ocean, although we may infer as much from early travel records, from the wide distribution of certain plants, or from the dependence of such plants on native cultivation for survival. All of this evidence is difficult to obtain. More could possibly be achieved by showing that different plants, descended from a common ancestor, were used as piscicides on opposite sides of the ocean. If these plants were of a type which had to be carried by human agency, we would be driven to accept that the transfer must have taken place in the pre-Columbian period in the same way (and possibly at the same time) as the transfer of the bottle-gourd, the black-fleshed chicken, and 13-chromosome cotton. Until these questions are settled, the prehistorian must keep an open mind on the subject and must refuse to argue an independent American invention of fish-poisoning based on the lack of the trait in the Bering Strait area.

NOTES

[1] This paper has been read by Dr. Edgar Anderson of the Missouri Botanical Garden and by Drs. Bernice G. Schubert and Walter H. Hodge of the Agricultural Research Service of the United States Department of Agriculture. I am grateful to these three authorities for correcting my botanical errors, but my conclusions and my lines of thinking in reaching these conclusions are my own responsibility.

[2] Heizer's paper is much more adequate in the New World than it is for either Africa or Asia. Much relevant material for the last two areas can be gleaned from Roark 1932; Roark 1937; Chevalier 1937; Chevalier 1912; Bally 1937; Heckel 1910; Chopra 1941; Quisumbing 1947.

[3] Heizer (p. 272) also identifies *Derris elliptica* as a fish poison used in Colombia. This is based on a misreading of Santesson 1935:25. The plant in question was identified by Santesson as *Tephrosia toxicaria*, the Derris being mentioned, only in passing, as a similar plant in Malacca. The same error appears in Heizer 1949: 278.

BIBLIOGRAPHY

ANDERSON, EDGAR
1952 Plants, Man, and Life. Boston, Little, Brown & Co.

ANONYMOUS
1884 Concerning the salmon fisheries of Bretagne. Bull. U. S. Fish Commission 4:185–186.

BALLY, P. R. O.
1937 Native medicinal and poisonous plants of East Africa. Kew Bulletin of Miscellaneous Information. No. 1, 10–26.

BENNETT, W. C. and ZINGG, R. M.
1935 The Tarahumare. University of Chicago Press.

BIOLOGICAL SOCIETY OF WASHINGTON
1919 Symposium: What kind of characters distinguish a species from a subdivision of a species? Journal of the Washington Academy of Science 9:234–238 and 187–192.

BIRD, JUNIUS
1948 America's oldest farmers. Natural History 57:296–303, 334–345.

BREUIL, HENRI
1954 Rock paintings of South Africa. Anthropological Quarterly 27:31–42.

BUTLER, ALFRED JOSHUA
1930 Sport in classic times. London, E. Benn.

CARTER, GEORGE F.
1953 Plants across the Pacific. American Antiquity 18, No. 3, pt. 2:62–71.

CHAPIN, J. P.
1932 Birds of the Belgian Congo. Bulletin American Museum of Natural History 65, pt. 1:1–756.

CHEVALIER, AUGUSTE
1912 Enumeration des plantes cultivée par les indigènes en Afrique tropicale et des espèces naturalisées dans le même pays, et ayant probablement été cultivées à une époque plus ou moins reculée. Bulletin de la société nationale d'acclimatation de France 59:65–79, 104–110, 133–138, 239–242, 312–318, 341–346, 386–392.

1937a Plantes ichtyotoxiques des genres *Tephrosia* et *Mundulea;* leur dispersion, leur culture, et leurs propriétes insecticides. Revue de botanique appliquée et d'agriculture tropicale 17:9–27.

1937b Plantes ichthyotoxiques des colonies françaises contenant du rotenone ou presumées en contenir. Revue de botanique appliquée et d'agriculture tropicale 17:565–585.

CHILDE, V. GORDON
1925, 1948 Dawn of European civilization (1st ed., 4th ed.). New York, Knopf.

1934 ,1952 New light on the most ancient East (1st ed., 3rd ed.) London, Routledge and Kegan Paul.

1949 Prehistoric communities of the British Isles (3rd ed.) London, W. & R. Chambers.

CHOPRA, RAM NATH
1941 Insecticidal and piscicidal plants of India. Journal of the Bombay Natural History Society 42:854–902.

CLAUSEN, JENS et al.
1939 The concept of species based on experiment. American Journal of Botany 26:103–106

COOK, A. C.
1900 Aborigines of the Canary Islands. American Anthropologist 2:451–493.

COON, CARLETON STEVENS
1943 Southern Arabia, a problem for the future. Papers of the Peabody Museum of American Archaeology and Ethnology, 20 (Dixon Memorial Volume).

CORBETT, CHARLES EDWARD
1940 Plantas ictiotoxicas. Universidade de São Paulo, Faculdade de Medicina, Monografias 1.

COUPLAND, REGINALD
1938 East Africa and its invaders, from the earliest times to the death of Seyyid Said in 1856. Oxford, Clarendon Press.

DANDOUAU, A. and G. S. CHAPUS
1952 Histoire des populations de Madagascar. Paris, Larose.

DANIEL, G. E.
1941 The dual nature of the Megalithic colonization of prehistoric Europe. Proceedings of the Prehistoric Society 7:1–50.

FERRAND, GABRIEL
1919 Le K'ouen-louen et les anciennes navigations interrocéaniques dans les Mers du Sud. Journal Asiatique 13:239–333 and 431–529; 14:5–68 and 201–241.
1934 Sayabiga; Wakwak. Encyclopedia of Islam. Leiden, Brill. 4:200–201 and 1105–1109.
1936 Madagascar. Encylopedia of Islam. Leiden, Brill 3:64–75.

FORBES, HELEN M.
1948 A revision of the South African species of the genus *Tephrosia*. Bothalia 4:951–1006.

GERTH VAN WIJK, H. L.
1911–1916 A dictionary of plant names. 2 vols. The Hague, Nijhoff.

GRANDIDIER, GUILLAUME
1885–1928 Histoire physique, naturelle, et politique de Madagascar. 28 vol., Paris, Imprimerie Nationale.

GROOT, GERARD J.
1951 The Prehistory of Japan. New York, Columbia University Press.

HAMLYN-HARRIS, R. and SMITH, F.
1916 On fish poisoning and poisons employed among the aborigines of Queensland. Memoirs of the Queensland Museum, Brisbane 5:1–22.

HAWKES, C. F. CHRISTOPHER
1940 The Prehistoric foundations of Europe to the Mycenean Age. London, Methuen.

HECKEL, ÉDOUARD
1910 Les plantes utiles de Madagascar. Catalogue alphabetique des plantes utiles et en particular des plantes médicinales et toxiques de Madagascar avec leurs noms malgaches et leurs emplois. Marseilles, Musée coloniale de Marseilles. Also in the Annales de la Musée 18 (ser. 2, t. 8):5–372.

HEIZER, ROBERT F.
1949 Fish poisons. Handbook of South American Indians. Bulletin 143, Bureau of American Ethnology 5:277–281.
1953 Aboriginal fish poisons. Bulletin 151, Bureau of American Ethnology, 225–283.

HERMANN, FREDERICK J.
1947–1949 Studies in *Lonchocarpus* and related genera. Journal of the Washington Academy of Science 37:427–430; 38:11–14, 72–75, 310–312; 39:306–313.

HORNELL, JAMES
1934 Indonesian influence on East African Culture. Journal of the Royal Anthropological Institute of Great Britain and Ireland 64:305–332.
1946 Water transport: origins and early evolution. Cambridge University Press.

HOWES, F. N.
1930 Fish poison plants. Kew Royal Botanic Gardens. Bulletin of Miscellaneous Information, No. 4, article 15:129–153.

JONES, HOWARD A.
1953 The rotenone content of derris root, cube root, and other plant materials. Journal of the Washington Academy of Science 23:36–46.

KELSEY, H. P. and W. A. DAYTON
1942 Standardized plant names. 2nd ed. Harrisburg, Pa.

Kew Royal Botanic Gardens
1911 The useful plants of Nigeria. Kew Bulletin of Miscellaneous Information 9, pt. 2:177–342.

Killip, E. P. and A. C. Smith
1931 The use of fish poisons in South America. Annual Report of the Smithsonian Institution for 1930, 401–408.
1935 Some American plants used as fish poisons. U. S. Department of Agriculture. Bureau of Plant Industry.

Krukoff, B. A. and A. C. Smith
1937 Rotenone-yielding plants of South America. American Journal of Botany 24:573–587.

Linton, Ralph
1933 The Tanala, a hill tribe of Madagascar. Chicago, Field Museum Publication No. 317, Anthropological Series vol. 22.

Martyn, E. B. and R. R. Follett-Smith
1936 The fish poison plants of British Guiana, with special reference to the genera *Tephrosia* and *Lonchocarpus*. Agricultural Journal of British Guiana 7:154–159.

Moloney, Cornelius A.
1887 Sketch of the forestry of West Africa with particular reference to its present principal commercial products. London: S. Low, Marston, Searle, and Rivington.

Nielsen, Ditlef, et al.
1927 Handbuch der altarabischen Altertumskunde. Copenhagen, A. Busck.

Panshin, A. J.
1937 Wood anatomy of certain South American rotenone-yielding plants. American Journal of Botany 24:587–591.

Pendelbury, J. D. S.
1939 The archaeology of Crete: an introduction. London, Methuen.

Pittier, Henri
1917 The Middle-American species of *Lonchocarpus*. Contributions of the U. S. National Herbarium 20:37–93.

Pulle, August A.
1906 An Enumeration of the vascular plants known from Surinam, together with their distribution and synonymy. Leiden, Brill.

Quisumbing, Eduardo
1947 Philippine plants used for arrow and fish poisons. Philippine Journal of Science 77:127–177.

Radcliffe-Brown, A. R.
1948 Andaman Islanders. Glencoe, Free Press.

Ripley, S. Dillon
1945 Suggested terms for the interpretation of speciation phenomena. Journal of the Washington Academy of Science 35:337–341.

Roark, Ruric C.
1932 A digest of the literature of *Derris* (*Deguelia*) species used as insecticides, 1747–1931. U. S. Department of Agriculture, Miscellaneous Publication No. 120.
1936 *Lonchocarpus* species (Barbasco, cube, haiari, nekoe, and timbo) used as insecticides. U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine.
1937 *Tephrosia* as an insecticide: a review of the literature. U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine.

Roig y Mesa, J. T.
1928 Diccionario botanico de nombres vulgares Cubanos. Havana; Rambla, Bouza y ca.

Rydberg, P. A.
1923 *Cracca*. North American Flora 24(3):157–185. New York, New York Botanical Society.

SALIL IBN RUZAIK
1871 History of the Imams and Seyyids of Oman from A.D. 661 to 1856. London, Hakluyk Society, No. 44.

SANTESSON, C. G.
1936 Pfeil- und Fischgift aus Kolumbien und Ekuador. Gothenburg Museum Ethnological Studies 2:15–29.

SAUER, C. O.
1952 Agricultural origins and dispersals. New York, American Geographical Society.

SCHERY, ROBERT WALTER
1952 Plants for men. New York, Prentice-Hall.

SENN, H. A.
1938 Chromosome number relationships in the *Leguminosae*. Bibliografia Genetica 12:175–336.

SMALL, JOHN KUNKEL
1933 Manual of the southeastern Flora. New York.

STANER, P. and R. BOUTIQUE
1937 Matériaux pour l'étude des plantes médicinales indigènes du Congo Belge. Brussels; Institut royal colonial belge; Section des sciences naturelles et médicales. Memoires. Collection in 8°, t. 5, fasc. 6.

STOKES, JOHN F. G.
1921 Fish poisoning in the Hawaiian Islands with notes on the custom in southern Polynesia. Honolulu, Bernice P. Bishop Museum. Occasional Papers 7, No. 10:219-233.

VIROT, R.
1950 Les plantes ichtyotoxiques en Nouvelle-Calédonie. Revue internationale de botanique appliquée et d'agriculture tropicale 30:86–88.

WATT, J. M. and M. G. BREYER-BRANDWIJK
1932 The medicinal and poisonous plants of southern Africa. Edinburgh, E. & S. Livingstone.

WILBAUX, R.
1935 Considerations sur *Tephrosia vogelii* Hook. f. et un certain nombre d'espèces voisines. Annales de Gembloux 41:1–30 and 41–96.

WILLIS, J. C.
1931 A dictionary of the flowering plants and ferns. 6th ed. Cambridge University Press.

WOOD, CARROLL E. JR.
1949 The American barbistyled species of *Tephrosia* (*Leguminosae*). Rhodora 51:193–231, 233–302, 305–364, 369–384.

WORSLEY, R. R. LE GEYT
1934–1936 The insecticidal of some East African plants: I. *Tephrosia;* II. *Mundulea suberosa*. Annals of applied biology 21:649-669 and 23:311–328.