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FOCUS: First Archaeological Indication of Fishing by Poison in a Sea Environment by the Engoroy Population at Salango (Manabí, Ecuador)

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The identification of bone remains of small rock fish among the fauna of an archaeological site on the coast of Ecuador, dated in the 1st millennium BC (Engoroy Culture), suggests a link between their fishing techniques and the use of a plant with piscicide properties, common on the Manabi coast: *Jacquinia sprucei*. The ecological and geographical distribution of this botanical species leads to the assumption of widespread pharmacological knowledge of its use in fishing along the coastline.

Keywords: ECUADOR, PRECOLOMBIAN FISHING, ARCHAEOICHTHYOLOGY, FISH POISON, *BARBASCO*, PALAEOETHNOBOTANY.

Introduction

Fishing by poison was well-known throughout the world in historical times (Heizer, 1953); in Europe it is first mentioned in texts by Aristotle (*Historia Animalium*, 4th century BC). In the rest of the world it was related by travellers from the 18th century, such as Rumph (1747) in Indonesia, or Juan & Ulloa (1748) in South America. The latter piece of evidence is of particular interest since it relates to facts observed in the Guayas Basin, near Guayaquil in Ecuador. For earlier periods archaeological proof is lacking, due to the often poor state of conservation of the organic material concerned. We know that a hundred botanical families are implicated in fishing by poison across the world (Acevedo-Rodríguez, 1990) and that the northern half of South America is notably rich in ichthyotoxic plants, well known by native populations and abundantly used in the Amazonian Basin (Heizer, 1949).

Fishing by Poisoning

This type of fishing brings into play substances, mainly of plant origin and belonging primarily to two molecular families: the rotenones, found almost exclusively among the leguminous plants (*Papilionaceae*, *Mimosaceae*, *Cesalpiniaceae*), and the saponins, more diversely distributed among the plant kingdom (*Amaryllidaceae*, *Convolvulaceae*, *Dioscoreaceae*, *Lamiaceae*, *Lecythidaceae*, *Liliaceae*, *Papilionaceae* *Sapindaceae*, *Scrophulariaceae*, *Solanaceae*, *Verbenaceae*, etc.). However, another large ichthyotoxic plant family, the *Euphorbiaceae*, notably with the *Phyllanthus* species, acts by liberating cyanide in water.

Rotenone, the active substance extracted hitherto from roots of *Derris elliptica* or *Lonchocarpus nicou* (*Papilionaceae*), is synthesized today and used in experimental fishing or in the elimination of undesirable species in fishing-ponds (Morrison, 1988). Saponines, heterosides of alcohol very frequent in plants, are frothy products that can be used as soap. ‘‘Soaproot’’ is an example (*Chlorogalum pomeridianum*, *Liliaceae*) whose roots contain a saponin extremely toxic for fish, hence its use for fishing by Indians of California. These two families of chemical substances are toxic for fish, yet not for men who consume them, at least in small doses, which explains their use in fishing. Their absorption by fish entails asphyxia, either by an inhibiting action at the mitochondrial breathing level, as in the case of rotenones, or by attack on the blood cells, in the case of saponins.

This type of fishing is suitable when the volume of water is fairly restricted or stagnant so that the poison reaches a sufficient level of concentration to be effective. It is generally practised in fresh water, sometimes briny (cf. Moretti & Grenand, 1982), and it is only in the Indo Pacific region that it is traditionally applied to the open sea; either in the inter-tidal pools of the Coral Reef, as at Rarotonga (Buck, 1928) and Madagascar (Petit, 1923), or in diving, as at Samoa (Buck, 1930: 444). It appears that it was also used by the

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Phoenicians for sea-fishing (cf. Aristotle, 1994: 454) and by Californian Indians, for octopus or low-tide shellfish fishing (cf. Heizer, 1953: 235).

Present Data

In Ecuador, diverse sources attest the use of poison for fishing in waterways of the western slopes of the country, even as far as the river mouths (Juan & Ulloa, 1748; Mitlewski, 1985; Holm, 1991; Lindao-Quimí & Stothert, 1994). The plant and its toxin are known locally under the generic term of ''barbasco''. This term, of Spanish origin, comes from the Latin ''verbascum'', a word translated by Pliny the Elder in *Naturalis Historia* (Book 25, paragraph 120) to denote a common group of medicinal plants with ichthyotoxic effects: mulleins (*Verbascum* spp., *Scrophulariaceae*). These last plants are those also cited by Aristotle (1994: 454). In the present case, the plant concerned is *Jacquinia sprucei* (syn. *J. pubescens*), a *Theophrastaceae* endemic to the Ecuadorian and Peruvian coasts taking the form of shrubs in the savannah and dry forests (Macbride, 1959; Balslev, Madsen & Mix, 1988). The active substance is a saponin, contained in the globulous fruit. It is a plant fairly common on the central Ecuadorian coast and its fruit is available from May to August, yet it no longer seems to be used for its chemico-toxic properties. Mitlewski (1985) attests its use by the Tchatchis Indians (Cayapas) in the Esmeraldas Province, but is this the same ''barbasco''? The plant shown in his article (Mitlewski, 1985: 74, figure 19) is not *Threophrastaceae*, and the ecological conditions of Esmeraldas are very different from those of the Manabí coast: it could be a *Fabacae* close to that used in a similar context by natives of the delta of the Río Patía in Columbia, *Muellera moniliformis* (Caballero-Muñoz, 1995).

Heizer (1953) suggests that the first reason for the use of plants with saponins would have been the exploitation of their soapy properties for domestic washing, leading to a secondary use as poison, after observation of the consequent mortality of aquatic organisms around the washing areas. In the same vein, Heizer thinks that the application to a marine environment was only secondary, following use in fresh water. We agree with this author on these two points, not forgetting that the fact that using one plant with diverse objectives, exploiting its different pharmacological, physiochemical or toxic properties, is not exceptional (cf. Bossard, 1993).

The Archaeological Data

In the context of the study of the archaeological site 141B-T3 of Salango (Norton, Lunniss & Nayling, 1983), our interest was focused on the Engoroy cultural phase of which the approximate chronological limits are 900–350 BC. During the archaeo-ichthyological analysis (Béarez, 1996*a*), the frequency of very small bones in certain contexts of the Engoroy II chronological level (no. 3.501, 3.668, 3.722, 3.763, 3.799, 3.938, 4.009, 4.034, 4.039, 5.783) led us to consider the hypothesis of fishing by poisoning. To start with, we had tried to identify these remains, with the idea of small *Engraulidae* (anchovies) or *Clupeidae* (sardines), small fish whose shoals could have been captured along the coast. However, given the small size of the bones, with the subsequent difficulties of identification, and our poor reference material for small species, the sparse number of bones (17) that we could identify, belonged to the Labridae family: 10 lower pharyngeals with a width comprised between 4 and 5·3 mm, and seven premaxillaries with a length between 4 and 6 mm. To reconstruct the body size of the fishes involved, we applied an osteometric model, formerly established for treating the ''Mexican hogfish'' (*Bodianus diplotaenia*, Labridae) (Béarez, 1996*a*), admittedly imperfect for the size of the sample and with the knowledge that we could be dealing with remains of another species of the same family, probably from the genus *Halichoeres* or *Thalassoma*. By applying the formulae given in the Appendix, it was possible to reconstruct individuals of a stature of a few centimetres (31–79 mm SL) for a weight of a few grams (1–13 g). On the other hand, the presence among the remains of numerous small hard spiny rays, as in the 4.009 context, implied the presence of Acanthopterygians; which diverged from the hypothesis of fishing by net for small Clupeiforms on a sandy bed. We therefore concluded on the possibility of capturing small rock fish, since there are no brackish water species among the Labrids of the Ecuadorian coasts (cf. Béarez, 1996*b*), and this by means of a specific technique, since no fish of an intermediate size (between 10 and 50 g) have been found. How could fish so small and quick be caught among rocks in a sea context more or less open? We suggest capturing by poison in water-holes left at low tide (inter-tidal pools).

An enquiry among several old fishermen in the old village of Salango informed us that, effectively, fishing with ''barbasco'' was still practised 40 or so years ago. This was the women's work, accompanied by young children. We also learnt that the plant used was first employed for its detergent properties before the introduction of industrial soap. Once the plant had been identified and located, the tests that we carried out by introducing poison in waterholes, were conclusive, although the captured species only represented three families: *Labrisomidae*, *Gobiesocidae* and *Gobiidae*. There are at least two reasons for this small diversity: (1) the rarefaction of the fish shoals according to the fishermen as a result of this practise and (2) our deliberate choice of small waterholes, less rich in fauna but more favourable to our tests.

Bibliographical research has also confirmed this old practise in the region: *Jacquinia sprucei* is noted as a poison by Killip & Smith in 1935. However, no mention has been made referring to sea water, but only to fresh (Juan & Ulloa, 1748; Holm, 1991) or to brackish water in river mouths (Lindao-Quimí & Stothert, 1994). As for the botanical species employed, the general use of the generic term ''barbasco'' for any ichthyotoxic plant has led to a certain confusion, aggravated by taxonomic and synonymous problems in the *Jacquinia* group.

Galzin (1985) mentions the traditional use of seeds of *Barringtonia asiatica* (*Lecythidaceae*) for fishing off the coral reef of Futuna in Melanesia and gives the results of fishing with rotenone experimented on the spot, in conditions similar to our own: the captured species were in majority Acanthopterygians with some *Labridae*. These different elements corroborate our initial hypothesis and encourage us to maintain it as the most probable, even if the identification of small bone remains is very fragmentary.

Another hypothesis, which has the advantage of explaining the presence of these small remains, consists of considering them as stomach contents of larger fish, eviscerated on the site. But we see some objections here:

(1) the bones are well conserved and show no traces of digestion, yet it seems difficult to imagine that they came from recently ingurgitated prey;
(2) they were found in large quantities but in a small number of contexts, which excludes a regular practise of eviscerating on the spot;
(3) lastly, the fish concerned are not present in the customary diet of the majority of the captured species, belonging to the *Scombridae*. Alone, among the other identified species on the site, *Serranidae* such at *Epinephelus labriformis* or *Mycteroperca xenarcha* could have been implicated as predators, but their representation is very small. The hypothetical predator/prey couple is only present in the 5.783 context.

In this case, what were the reasons for this fishing and the use of these small fish? They were not consumed directly, for the very small bones would have been digested and would have disappeared through the intestinal tract (cf. Jones, 1986). On the other hand they could have been part of a preparation similar to a sauce (*garum*) or a soup in which the flesh is dissociated from the bones, which drop to the bottom of the pot and are then discarded. The fishermen interrogated spoke of the preparation of a soup made in the past with shellfish, crabs and small fish, on their return from fishing by foot. This collecting activity was probably part of the socio-cultural role of women, but in a society where fish of large or middle sizes were surely not lacking, the capture of small fish was a secondary element in fishing more oriented towards invertebrates (octopus, shrimps, etc.), also subject to poisoning.

In another context, at the Neolithic site of Orkney (GB), Wheeler (1979) identified pharyngeal bones from Labrids and suggested that they were captured in inter-tidal pools. However, these fish were larger (120–180 mm TL) than the specimens from Salango, indicating a possible capture by line fishing, or by hand or by harpoon. Nevertheless, this confirms that rock fish which would not be considered consumable today, being too small, were not neglected in older times.

Finally, there is, however, a contextual perspective available. The bones derived from an area of intense ritual activity, involving the burial of humans, and also the deposition of figurines, animals and other artefacts. Associated with these interments were a number of rubbish pits with a high content of smashed pottery, and this pottery was most likely used for the preparation and serving of food and drink during the rites. All but two of the bones came from pits of this sort, and the two exceptions were from contexts adjacent to such pits (R. Lunniss, pers. comm.).

It would seem then, that the fish were actively sought for exclusive use on certain ritual occasions. This in turn suggests a particular symbolic significance for which we have, as yet, no complementary evidence and if their capture was indeed effected through the use of poison, then that method of fishing may itself need to be linked to the occasion of the rites.

Discussion

Jacquinia is a typical neo-tropical type, its distribution covering Mexico to Peru and Brazil, with a diversification in the West Indies. In South America it is characteristic of the dry coastal forests: solely *J. mucronata*, collected by Humboldt and Bonpland, is confined to the upper valley of the Rio Marañon in the Peruvian Andes (Figure 1). The species re-groups, according to Ståhl (1995), 32 valid types widely used as ichthyotoxins: *J. macrocarpa*, *J. seleriana* in Mexico (Standley, 1920–26); *J. armillaris* in the Antilles (Heizer, 1953) and in Venezuela, where *J. frutescens* is also found (Vellard, 1939); and *J. sprucei* in Ecuador and Peru (Balslev, Madsen & Mix, 1988; Ståhl, 1990). The Andean type, *J. mucronata* should be noted, but does not seem to have been used as a poison (Killip & Smith, 1935).

If the use of a piscicide might be indicated by these first elements on the Ecuadorian coast in the 1st millennium BC, it is however only probable and not at all certain that *Jacquinia sprucei* was the plant employed. In this assumption, *Jacquinia* being absent in the interior of the South American continent and showing no morphological resemblance to the Amazonia ichthyotoxic plants (essentially *Papilionaceae* of the *Lonchocarpus* and *Tephrosia* genera and *Sapindaceae* of the *Serjania* genus), is possibly an argument in favour of a coastal transmission of pharmaco-botanical knowledge (Figure 1). But, unless there were several sources of discovery, the direction of its propagation is yet to be determined. The facts that are presented here, should they prove to be exact,

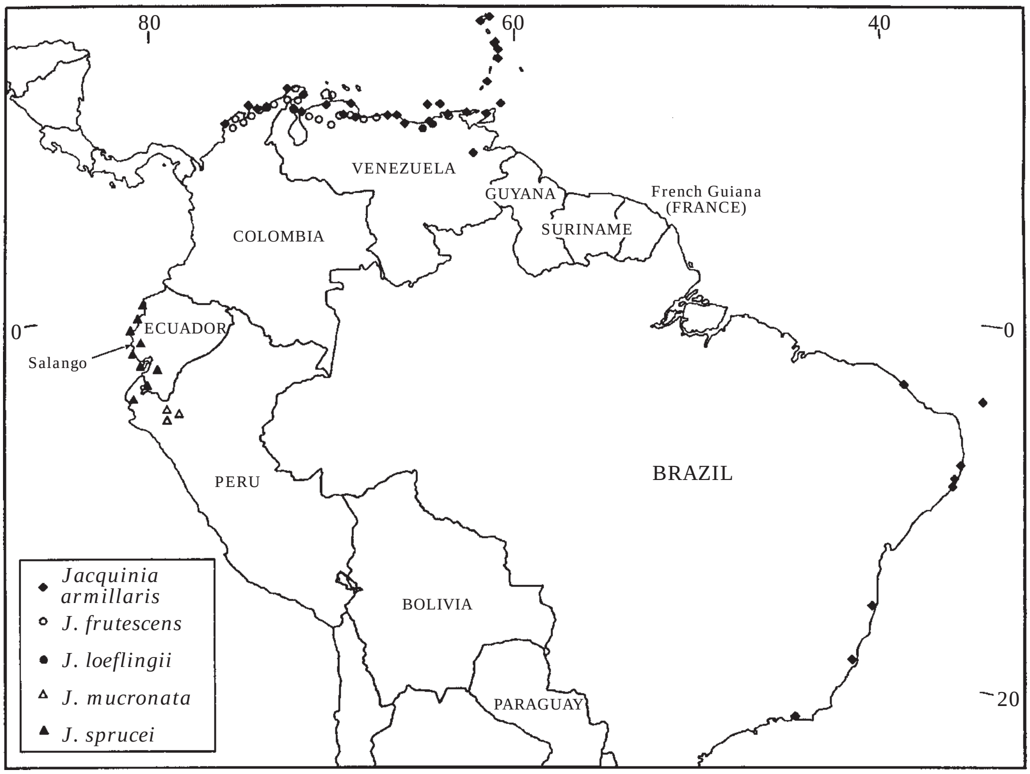

Figure 1. Location of Salango and distribution of *Jacquinia* species in South America (after Ståhl, 1989, 1992, 1995).

nonetheless tend to refute Quigley's (1956) vision, which placed the origin of the use of ichthyotoxic plants in Africa towards tropical America. Such a development of navigation in the 1st millennium seems highly improbable; the date should even be higher if we consider the necessary delays for the propagation of this knowledge across the sub-continent to reach the Ecuadorian coastline.

Conclusion

In the absence of written testimonies, archaeological data suggest the possible use of ichthyotoxic plants in South America, at a period at least as ancient as that of the first written descriptions around the Mediterranean. However, these results must be corroborated by pluridisciplinary analyses of other sites in order to transform into proof the first indications presented here.

This study also shows, once more, the importance of systematic sifting and the use of flotation techniques for reconstructing palaeo-environments and palaeo-economies. Information thus obtained must complete and enrich results classically deducted from large bones recovered by hand. In this respect, the multiplication of elaborate studies in neo-tropical coastal archaeo-ichthyology should be able to bring elements of response to the problems of the origin and age of this type of fishing in pre-Hispanic America.

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Appendix

Osteometric model formulae:

Length/weight relationship:

$$W = 1{\cdot}9462 \times 10^{-5}\ \mathrm{SL}^{3{\cdot}0683}$$

$$(N = 21;\ 0{\cdot}389 \leq W \leq 3{\cdot}450\ \mathrm{g};\ r = 0{\cdot}992)$$

ML/SL relation:

$$\mathrm{SL} = 8{\cdot}428 \times \mathrm{ML}^{0{\cdot}94896}\ (N = 15;\ r = 0{\cdot}978)$$

MW/SL relation:

$$\mathrm{SL} = 20{\cdot}848 \times \mathrm{MW}^{0{\cdot}80027}\ (N = 15;\ r = 0{\cdot}958)$$

Where N = number of specimens used for establishing the model, W = weight, r = correlation coefficient, SL = standard length, TL = total length, ML = maximum length, MW = maximum width.

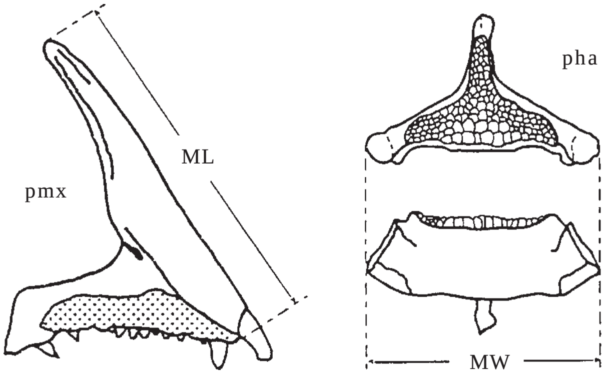

Figure 2. Premaxilla (pmx) (inner view) and lower pharyngeal (pha) bone (dorsal and cranial views) of *Bodianus diplotaenia*. ML, maximum length; MW, maximum width.

Table 1. Repartition by taxa of the fish bones from all the contexts discussed

	Contexts									
	Ritual area							Adjacent area		
Taxa	3722	3763	3799	3938	4009	4034	4039	3501	3668	5783
Selachimorpha	—	—	—	—	—	1	—	—	—	—
Elops affinis	—	—	1	—	—	1	—	—	—	—
Ariidae	—	—	—	—	—	—	—	—	—	2
Hemiramphidae	—	—	—	1	—	—	—	—	—	—
Epinephelinae	—	—	—	—	—	—	—	—	—	2
Epinephelus labriformis	—	—	—	—	—	—	—	—	—	1
Mycteropera xenarcha	1	—	—	—	—	1	—	—	—	1
Paranthias colonus	—	—	—	—	—	—	1	—	—	—
Paralabrax callaensis	—	—	—	—	—	1	1	—	—	—
Caranginae	—	—	1	—	1	—	—	—	—	—
Caranx sp.	—	—	1	—	—	—	—	—	—	—
Caranx caninus	—	—	—	—	—	—	—	—	—	3
Chloroscombrus orqueta	—	1	1	—	—	—	—	—	1	—
Haemulidae	—	—	—	—	—	—	4	—	—	2
Calamus brachysomus	—	—	—	—	—	1	—	—	—	—
Sciaenidae	—	—	—	—	1	—	—	—	—	—
Umbrina xanti	—	—	—	—	—	—	2	—	—	—
Pomacentridae	—	—	1	—	—	—	—	—	—	—
Labridae	—	—	4	6	1	2	2	1	—	1
Bodianus diplotaenia	—	—	—	—	—	—	—	—	—	1
Scombridae	—	—	21	2	2	2	—	—	—	—
Sarda orientalis	—	—	—	—	—	2	—	—	—	—
Scomber japonicus	—	2	—	—	—	—	—	—	—	—
Thunnini	7	1	1	—	1	1	1	—	—	6
Auxis sp.	—	2	—	—	1	1	1	—	—	—
Euthynnus lineatus	20	—	—	—	4	30	—	—	—	2
Katsuwonus pelamis	—	—	—	—	—	2	—	—	—	11
Thunnus albacares	—	—	—	—	—	—	1	—	—	5
Balistidae	1	—	—	—	—	—	1	–	–	–
Spoeroides sp.	—	—	—	—	—	4	—	—	—	3
Total										
identified	29	6	31	9	11	50	14	1	1	40
unidentified	130	127	618	116	262	216	168	0	21	187