

## The Natural History of *Equisetum* in Costa Rica\*

by

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In Costa Rica there are three species of *Equisetum*, *E. bogotense*, *E. giganteum*, and *E. myriochaetum*. In addition, there is a widespread hybrid between the latter two called *E. × schaffneri*.

*Equisetum bogotense*, a member of the subgenus *Equisetum*, is the Latin American equivalent of *E. arvense* in being the most common and in often forming extensive stands along road cuts and other disturbed places. Like that species also, it seems to possess as a normal habitat river beds and banks, and in fact appears to be most closely correlated in habitat with an abundant supply of ground water. Unlike *E. arvense* to the north, *E. bogotense* does not display seasonality in Costa Rica. Since the seasons here are wet and dry and since *E. bogotense* always grows in places where there is abundant ground water it is an essentially seasonless environment. Every stand I have seen and every time I have seen it *E. bogotense* has displayed young stems just emerging, old stems dying, and mature stems bearing cones. The cones in this species are borne on ordinary vegetative stems. Again, this growth habit is comparable to *E. arvense* in which new stems appear throughout the growing season. However, in that species, the advent of cold weather kills all aerial growth whereas in *E. bogotense* there is no such traumatic event and I cannot say what limits the life span of an aerial stem or even how long this stem lives.

Further similarity between *E. bogotense* and *E. arvense* is seen in its response to injury or stress. The apical meristem often aborts and laterals grow out producing a cluster of compound branches that appear to be small, upright

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or decumbent stems. In exposed places, the plants are short and compact (Fig. 1), in more protected places they become taller with spreading branches and in brushy places they reach a height of six feet, but become thin, straggly, almost vinelike plants (Fig. 2). It is interesting to note that in exposed places the plants cone freely, but in partially shaded places the cones become sparse and in complete shade cones are completely absent.

*Equisetum bogotense* is confined to the mountains of Latin America, ranging from Costa Rica south to Argentina. It is a plant of the higher altitudes and in Costa Rica I have seen it only above 1000 meters and up to 2900 meters. The usual habitats are along canals and rivers, in marshy places, and on roadside cuts or banks (Fig. 3). It was found on a wide variety of soil types and at various pHs. As noted above the most obvious requirement is a plentiful supply of ground water. Occasionally it is found growing up through road fill or recently deposited sands of a river bed in places that appear superficially dry and barren. The extensive horizontal rhizome system supplies it with plentiful water either from under the fill or from adjacent wet areas. I think this growth habit, the extensive rhizome system sending up aerial stems, has been of exceeding importance to the genus *Equisetum* in its survival since paleozoic times.

One serious limitation for many horsetails is inability to tolerate shade. The plant is a poor competitor and if shaded it stops coning, persists for awhile, and eventually loses out in competition for space to other plants. Since its rhizome system is able to penetrate into areas of recent sand deposition and there send up aerial stems, *Equisetum* is able to invade barren areas rapidly (Fig. 4). Other vegetation requiring establishment from seeds or slow-growing rhizomes requires more time to invade this newly created land. Thus the horsetails have a few years in a given place during which time perhaps another area of sand deposition will be developed. If a particular stand is eroded by the river, sections of rhizome will be washed out, carried downstream and there deposited to vegetatively reproduce the stand in a new locality. The horsetails appear ideally adapted for life along rivers, where sand deposition and erosion are continual features of the environment, because of their growth habit of an underground rhizome system which grows rapidly, spreads horizontally for great distances, and sends up aerial shoots. This is further enhanced by the ease with which vegetative propagation by pieces of the rhizome can occur.

The altitudinal limitation on growth of *E. bogotense* is not easy to understand. Soil composition and pH do not appear to be critical. Moisture alone seems essential. Temperature comes to mind as a possibly important factor for at higher altitudes it is consistently cooler than at lower altitudes. However, one would then expect *E. bogotense* to occur at lower altitudes at more northerly latitudes. It is found at higher altitudes in more southerly latitudes. Perhaps warmer temperatures combined with sufficient moisture permit other plants to grow so rapidly as to overpower *E. bogotense* whereas at cooler temperatures it can hold its own. Possibly also light intensity and quality, different at higher than at lower altitudes, are critical.

A factor of considerable importance in the life of many plants but one often overlooked is their relationship with insects and other animals (JANSEN, 3). Among the horsetails, however, no such relationships have been observed. Insects rarely if ever feed on them, lay eggs in them, or otherwise live together with the horsetails. Nor do they appear to be bothered with fungus or other diseases. Perhaps *Equisetum* evolved before the insects and has outlived any plant parasites. Possibly it is simply that the silica coat which is characteristic of the genus *Equisetum* discourages insects and other symbionts.

The gametophytes in culture, however, were subject to attacks by insect larvae. In fact, these seemed to prefer *Equisetum* gametophytes to the fern gametophytes which were occasionally present as contaminants.

The other two species of *Equisetum* found in Latin America and their hybrid are members of the subgenus *Hippochaete* and appear quite different from *E. bogotense*, being giant members of the genus (Fig. 5). They reach a height of 20 feet in Costa Rica, and are reported to reach 30 feet elsewhere (but this is not substantiated by any specimens I have seen). These also grow in wet places such as the edges of river beds and marshes. In Costa Rica they are found at somewhat lower altitudes than *E. bogotense*, 550-1400 meters.

The giant horsetails are more restricted in their distribution than the small one, being absent from the highlands to the north and east of the Meseta Central. A look at geologic and soil maps of Costa Rica (AID/RIC GIPR # 4, maps L9 and L10) reveals that they occur in the Cordillera de Talamanca and related highlands, which are sedimentary in origin, but are absent from the Cordillera Central and Cordillera Tilarán, igneous volcanic highlands (Fig. 6). It is difficult to see why this should affect the distribution, since the colonies of giant horsetail usually occur in alluvial enclaves, not on parent soils.

The discussion above of the shading out or erosion of stands and their re-establishment elsewhere by rhizome growth, or water transport and deposition of rhizome segments, also applies to the giant species (Fig. 7). Several times in our search for "Cola de Caballo grande" we were told by "campesinos" that it had formerly been present in a certain place but was no longer there. To cite one case, there is a specimen of *E. myriochaetum* in the National Museum in San José, from "Merécage dans la plaine du Rio Ceibo, 200 metres" collected by Tonduz in 1892. We went to that place but could find no marshes and no giant horsetail. A man in nearby Buenos Aires, of Indian descent, told us that it had been there in his grandfather's time, but was no longer around. We also observed among the giant horsetails as among the low horsetails that if part of a stand were shaded and part in the sun, the sunny part would be coning, the shady part would be only vegetative.

Other remarks made about *E. bogotense* but applicable also here are the tolerance of various soil types and Phs, the absence of insect and fungus relationships and the lack of seasonal development. The number of cones present did seem to decrease appreciably during the dry season, but growth of new stems and death of old continued. Unlike "Cola de Caballo pequeña" the tall horse-

tails have hard, fibrous stems, which appear more like the stems of the evergreen species of North America, and probably last longer than do those of *E. bogotense*.

Of the giant horsetails *E. giganteum* is the most well known. It occurs from Guatemala to Chile, Argentina and Brazil, and in the Caribbean islands. In Costa Rica it is found around the west and south edges of the Meseta Central, at altitudes of 740 to 1100 meters. I have seen it in seven different places in Costa Rica. Also found in six places in Costa Rica, with a distribution similar to *E. giganteum*, is *E. × schaffneri*, its hybrid with *E. myriochaetum*. The range of the hybrid in Latin America is more limited than that of *E. giganteum*, being known only from Mexico to Peru as its other parent, *E. myriochaetum*. In altitude in Costa Rica it is similar to that recorded for *E. myriochaetum*, for I have found it at between 550 and 1400 meters above sea level.

*Equisetum myriochaetum* was found by us in only one place, at Canaan near San Isidro del General, which is considerably south of the other giant horsetails. There it occurs at 1300 meters. One other record as mentioned above is from further south yet near Buenos Aires and at 200 meters above sea level, which is quite a bit lower than the other localities in Colombia or Mexico. There are two herbarium records for it near Cartago: Cartago, 4600 ft. (1400 m) June, 1928, H. E. Stork 1888 (OS); 10 miles south of Cartago, 2000 ft. (600 m) 9 Aug. 1940, M. A. Chrysler and W. E. Roever 5464 (UM). These two localities could not be located from the information given. Perhaps it was formerly more widespread but was less able to tolerate changes brought about by the clearing and settlement of the land and disappeared from most of the Meseta leaving only its hybrid as evidence of its former presence.

Another possibility, the *E. × schaffneri* is not of hybrid origin could be presented and substantiated by its presence in Veracruz, Mexico, north of the range of *E. giganteum* and in Venezuela, east of the range of *E. myriochaetum*. However, it is a perfect intermediate between these two, having one to three rows of stomata per band (*E. myriochaetum* has one, *E. giganteum* has 2-4) (Figs. 8-10), saw-toothed to squarish silica projections along the branches (*E. myriochaetum* has saw-tooth projections, *E. giganteum* has square) (Figs. 11-13), and individual endodermises (*E. myriochaetum* has a double common endodermis, *E. giganteum* has individual endodermises) (Figs. 14-16). This intermediate morphology and the irregularity of meiosis and complete abortion of the spores (Figs. 17-18) seem overwhelming evidence in favor of its hybrid nature. Because of the rampant vegetative reproduction in *Equisetum* a hybrid could, once formed, persist for hundreds of years. Perhaps that is the most likely explanation, that the hybrid was formed when *E. myriochaetum* was common on the Meseta Central and has persisted since.

The giant horsetails and the low one as well are widely known among the country people of Costa Rica because of their use as medicinal plants (MANFREDI, 4). Probably this use is a cultural heritage from Spain where members of the genus are also used medicinally (FONT QUER, 2). An infusion is made by boiling the stem of *Equisetum*, often together with corn tassel, asparagus stem, or some other plant, and the liquid is drunk as a cure

for kidney trouble. Small bundles of *E. Xschaffneri* are available from a stall selling medicinal plants in the public market in San José (Fig. 19).

The familiarity of the campesinos with *Equisetum* was a great advantage to me locating stands of the giant horsetail. Since the tall *Equisetums* grow in wet places such as in marshes and along rivers and since these places are difficult of access it is impractical to wander about at random hoping to discover stands of *Equisetum*, particularly because these plants are relatively uncommon. The local botanists knew of only three localities and the herbarium at the National Museum yielded a fourth, no longer in existence. To discover more localities and thus provide a broader spectrum of habitats for field study I would look over topographic maps, select an area that had several small streams accessible by road, go there and ask the local inhabitants if they knew Cola de Caballo and if so where it could be found. Though often unsuccessful, this method did yield several additional localities for the giant horsetails. The low horsetail *E. bogotense* is common at elevations above 1100 meters so there was no difficulty locating various stands of that species.

It was interesting to observe that not only do the people of Costa Rica utilize *Equisetum* but also that the cattle graze upon it with apparent relish. Eight of the 14 stands of giant horsetail were in areas in which cattle graze and at all eight those portions of the stand available to cattle were grazed close to the ground or to a level of vegetation such as *Mimosa* which the cattle did not take. Along fence rows this was particularly dramatic for if the cattle could reach their heads through the fence the plants within a head's reach would be eaten whereas if the cattle couldn't reach through the fence there would be an abrupt wall of *Equisetum* at the fence. In one place a campesino claimed that Cola de Caballo was good for the cattle, preventing some trouble with their blood. I found this particularly interesting because in Europe horsetail is considered a noxious weed in pastures; *E. palustre* has been indicted in the poisoning of cattle and a major effort is made there to eliminate *Equisetum* from pasture land (MUKULA, 5).

The gametophytes of the Latin American *Equisetums* have not been studied previously. Such studies were the principal purpose of my work in Costa Rica and will be reported upon in another paper. I was not able to locate any gametophytes growing wild, yet the copious spore production throughout the year by the tropical horsetails would certainly lead one to expect their presence. Possibly here again as discussed above, competition is a major factor. The gametophytes require an open place with abundant moisture supply but not flooded. They require two months to reach sexual maturity. Probably in any suitable place, within two months other vegetation has become established and overgrown the low gametophytes, shading them out and inhibiting their development. Further, they might be grazed upon and destroyed by insect larvae. Several times in my cultures an invasion by insect larvae occurred. These grew rapidly in size, and were able to completely destroy a petri plate full of nearly mature gametophytes within a couple of days.

As with other plants so also with *Equisetum* a study of the organism in

its natural surroundings reveals much which cannot be learned in any other way. The Latin American horsetails show some similarities to the North American horsetails, features of the genus itself and its survival and development since Paleozoic times. They show, in addition, some features peculiar to themselves, probably attributable to their adaptation to tropical habitats. In all of these things and in the primeval aspect displayed by stands of the giant horsetails (Fig. 20), the genus *Equisetum* is a fascinating group of plants.

### SUMMARY

Observations on the biology of the four horsetails found in Costa Rica are presented. The small *Equisetum bogotense* ranges from Costa Rica south to Argentina; it is widespread in altitudes between 1000 and 2900 m and shows many similarities with *E. arvense* of the North, except for seasonality, to which the local environment is not conducive. Two giant horsetails, *E. giganteum* and *E. myriochaetum*, occur in this country, in restricted localities; between 550 and 1400 m only one population of the latter was located, but several sites were recorded for *E. Xschaffneri*, considered to be an hybrid between the two species.

### RESUMEN

Se presenta una serie de observaciones sobre la historia natural de las cuatro equisetáceas que se encuentran en Costa Rica. *Equisetum bogotense* es una planta pequeña cuya distribución abarca desde este país hasta Argentina. Abunda en paredones, claros y orillas de cauces de agua entre los 1000 y los 2900 m de altitud. No muestra comportamiento estacional, sino que en toda época se propaga y fructifica. Al sufrir daño sus ápices, produce abundantes ramas laterales; en sitios soleados produce estróbilos y se quedan cortas las plantas. En sombra o en matorral tiende a crecer hasta casi 2 m con hábito rastrero, pero no produce esporas. Al sufrir erosión sus localidades, los rizomas arrastrados por el agua colonizan fácilmente los terrenos aluviales.

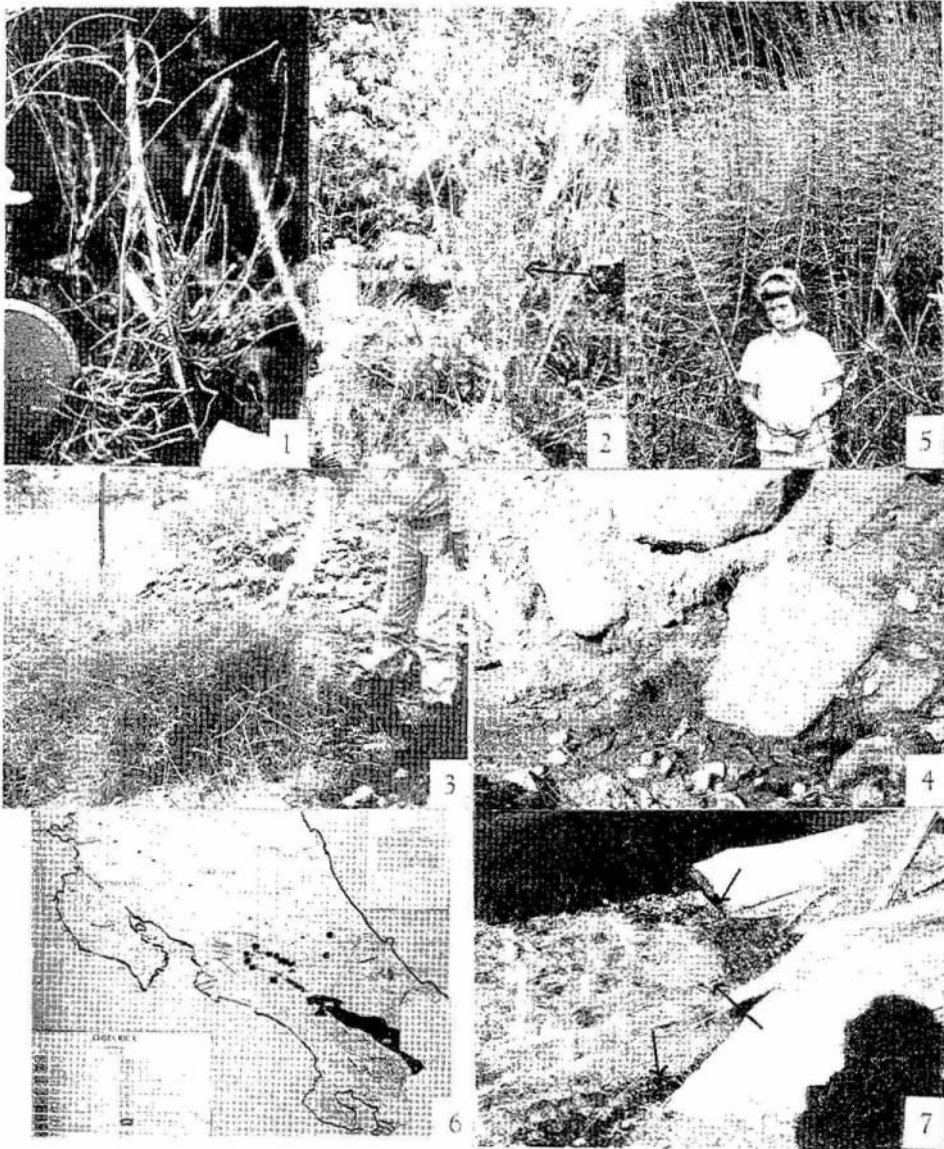
Dos especies gigantes de *Equisetum* habitan en lugares pantanosos entre los 550 y 1400 m de altitud. *Equisetum giganteum* fue hallado en la región sud oeste de la Meseta Central; *E. myriochaetum* sólo en un sitio, Canaán, cerca de San Isidro del General, aunque existen ejemplares de años recientes de la región de Cartago. *Equisetum Xschaffneri*, que se interpreta como híbrido de estas dos especies, fue hallado en seis sitios en el oeste y sudeste de la Meseta Central. Estos equisetos grandes sobreviven con dificultad cuando otra vegetación se desarrolla hasta producirles sombra, que parece impedir la producción de estróbilos y el desarrollo de los gametófitos.

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- Figs. 1-4. *Equisetum bogotense*.
- Fig. 1. Closeup showing low form characteristic of open places.
- Fig. 2. Tall form (arrow) among other vegetation, Quebrada Salitral near Sta. Teresa above Cajón.
- Fig. 3. Dense clump along roadside, Tapantí.
- Fig. 4. In area of erosion and deposition, bed of Rio Virilla, near San Isidro de Coronado.
- Fig. 5. *Equisetum Xschaffeneri*. Linda Vista farm, Dulce Nombre de Cartago.
- Fig. 6. Map of Costa Rica showing geologic formations. Circles *E. giganteum*; squares, *E. Xschaffeneri*; triangle, *E. myriochaetum*.
- Fig. 7. Rhizomes of *E. myriochaetum* (arrows) subject to erosion by Rio Chirripó Pacifico, near Canaán.





Figs. 8-10. Epidermal mounts to show stomatal arrangements,  
×75.

Fig. 8. *E. Xschaffneri*.

Fig. 9. *E. myriochaetum*.

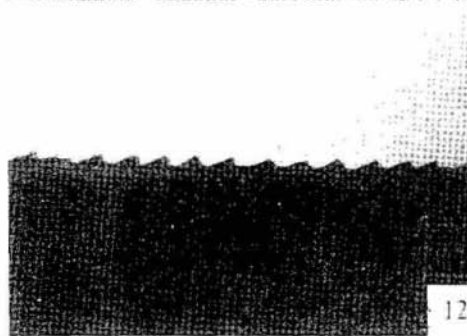
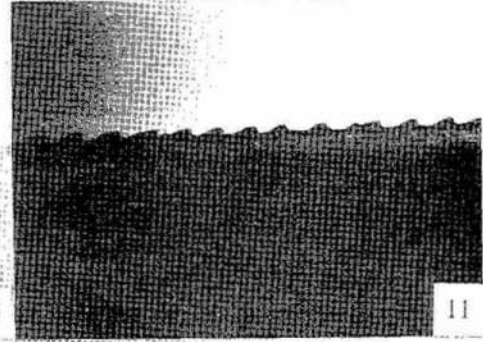
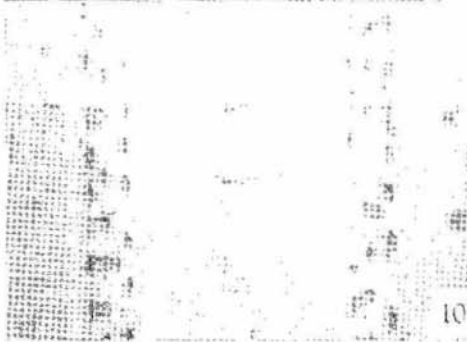
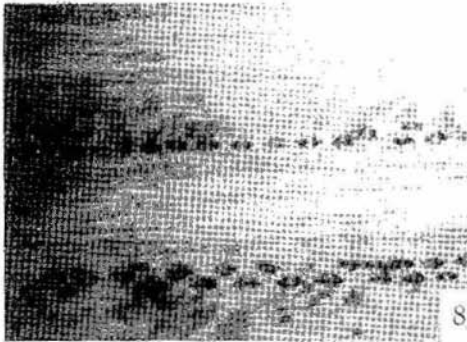
Fig. 10. *E. giganteum*.

Figs. 11-13. Profiles of branch ridges showing silica patterns,  
×75.

Fig. 11. *E. Xschaffneri*.

Fig. 12. *E. myriochaetum*.

Fig. 13. *E. giganteum*.



- Figs. 14-16. Cross sections of stem internodes showing endodermal patterns (arrows),  $\times 75$ .
- Fig. 14. *E. schaffneri*, with individual endodermises.
- Fig. 15. *E. myriochaetum*, with outer and inner common endodermises.
- Fig. 16. *E. giganteum*, with individual endodermises.
- Figs. 17-18. Spores,  $\times 190$ .
- Fig. 17. Irregular, misshapen, achlorophyllous spores of *E. schaffneri* nonviable.
- Fig. 18. Spherical, chlorophyllous, elatered spores of *E. giganteum*, viable.
- Fig. 19. Bundle of *E. schaffneri* as purchased in central market of San José.
- Fig. 20. Author standing by an extensive stand of *E. schaffneri*, Salitral de Desamparados, Costa Rica.

