# AQUATIC PLANT-INVERTEBRATE AND WATERFOWL ASSOCIATIONS IN MISSISSIPPI[1]

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## ABSTRACT

*A modified Gerking sampler was used to sample standing crops of invertebrates associated with aquatic plants common to Alabama and Mississippi. Appearance and disappearance of the aquatic plant communities sampled were also ascertained. The aquatic plants which persisted during the winter months were* Wolffiella floridana *and* Hydrocotyle ranunculoides. *Two other aquatic plant species which produced large standing crops of invertebrates were* Cabomba caroliniana *and* Ceratophyllum demersum; *however, these plants did not persist in winter and early spring when a source of invertebrates is important in the diet of the female nesting wood duck.*

The importance of aquatic plants as an attachment place for aquatic invertebrates has long been recognized (Krecher 1939, Rosine 1955); however, not until recent years has any quantitative data been gathered on the amount of various invertebrate taxa associated with different species of aquatic plants. Krecher (1939), Rosine (1955), Moyle (1961), and Krull (1970) have reported differences in the amounts of invertebrates harbored by different aquatic plant species in the North, Midwest, and West but very little work of aquatic plant invertebrate relationships has been reported from the South.

Aquatic invertebrates are the major constituents in the food chain of many aquatic organisms. Recent studies have shown the importance of aquatic invertebrates in supplying the very essential animal protein required by breeding waterfowl hens and newly hatched ducklings (Holm and Scott 1954, Johnson 1971). Cook (1964) states that wood ducks, the most abundant breeding species of waterfowl in the South, fail to reproduce when deprived of a diet high in protein and may actually reject areas where an invertebrate source is scarce. Thus, it becomes important to know the quantity of invertebrates associated with different plant species so that management can favor those hydrophytes possessing the largest invertebrate standing crops.

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One factor affecting invertebrate availability and one which has been largely neglected in the past is the relative periodicity of different species of aquatic plants. Many aquatic plants die with the advent of cold weather, and correspondingly the dependent aquatic invertebrates die. The removal of aquatic invertebrates from the food chain has a pronounced effect on other aquatic organisms. For example, Arner et al. (1974) found greater wood duck populations and larger clutch sizes to be present in areas where aquatic vegetation remained throughout the winter and provided invertebrates as a source of protein to wood ducks during their late winter-early spring nesting period.

Rosine (1955) stated that generally the introduction of plants into an aquatic environment immediately creates new niches for the existence of animal species. However, to date there is no information as to what species of aquatic plant produces the best results for any particular animal population. As a result of three studies in Mississippi during three separate years, invertebrate standing crops and plant periodicities were ascertained for several species of aquatic plants, largely to determine their values with respect to breeding waterfowl.

## STUDY AREA

A number of wetland types occur throughout Mississippi and the South—each possessing its own characteristic group of living organisms. To adequately determine invertebrate producing qualities of different species of aquatic plants, the study was conducted on a broad scale to include a variety of wetland types occurring within a wide range of soil conditions. From this information, consistency in the plant's performances to produce aquatic invertebrates were observed as they occurred naturally in various wetland types.

During the three year study, samples were taken at Ross Barnett Reservoir near Jackson, Mississippi, at small cypress sloughs, beaver ponds and inland fresh marshes on the Noxubee National Wildlife Refuge, at large wooded brakes (cypress-willow) and inland fresh marshes on the Yazoo National Wildlife Refuge, and at various wetland types occurring adjacent the Tombigbee River from Tishomingo County, Mississippi to Sumter County, Alabama.

## METHODS

Initially several different methods were used for sampling aquatic plant-invertebrate associations. An Ekman dredge was used in several different plant communities; however, it was found that the jaws of the dredge were frequently clogged with debris and plant material and often failed to close properly. Due to frequent malfunction of the dredge, the technique was abandoned. Judd traps were tried for sampling emerging aquatic insects, but due to the constant disturbance of the traps by people and animals, the traps were removed and a sampler, modified after Gerking (1957), was developed and used for all subsequent collection work.

The sampling device was a rectangular box constructed from sheet metal with a sliding screen door at the bottom (Fig. 1). Sampling was conducted by lowering the box, with the screen door open, to a depth of eight inches into the water over an aquatic plant community. The door was then closed to encompass the vegetation and the invertebrates it contained. The protruding stems which were not clipped by the sharpened edge of the sliding door were cut with hand shears. The sampler was removed from the water and immediately placed over a number three wash tub where the screen door was removed, permitting the vegetation to fall into the tub. The screen was then washed free of invertebrates by pouring water on its bottom surface allowing the washed material to fall into the tub. The plants and the invertebrates they harbored were then taken to the laboratory in plastic bags where the invertebrates were separated from the vegetation, identified, counted, and weighed. All standing crop data in this work are based on wet weights.

Sites for invertebrate collections were chosen by placing a compass staff in the center of an aquatic plant community. A wooden arrow on top of the staff was spun to randomly select a sampling line within the community. The sampling sites were selected at a

Figure 1. Sampler in position over plant community, showing sliding door open.

distance three meters from the compass staff and at three-meter intervals along with sampling line.

During 1967-68, two samples were taken in each of 13 species of aquatic plants at bimonthly intervals, beginning in February and continuing through May. During the 1967-68 study, samples were taken at Ross Barnett Reservoir and on the Noxubee National Wildlife Refuge.

During 1969-70, 16 species of aquatic plants were sampled from the beginning of September through May, taking three samples per plant community at bimonthly intervals. All sampling during 1969-70 was conducted on the Noxubee and Yazoo National Wildlife Refuges in Mississippi.

During 1972-73, bimonthly samples were taken in each of 24 plant species from the beginning of September through May. All sampling during 1972-73 was conducted in wetlands near or associated with the Tombigbee River from Tishomingo County, Mississippi, to Sumter County, Alabama.

## RESULTS AND DISCUSSION

Moyle (1961) reported that the protein content of leaves and stems of aquatic plants is between one and two percent of the wet weight; rhizomes and tubers average about two percent, and seeds and fruits may average about ten percent protein. Although the ten percent protein afforded by fruits and seeds would seem enough to fulfill the eight percent protein requirement which Holm and Scott (1954) reported to be a satisfactory level for ducklings, their role as a protein source may be negligible since fruit formation in aquatic plants is the exception rather than the rule, as most reproduction is accomplished asexually (Sculthorpe 1967). Aquatic invertebrates, on the other hand, are composed of between 10 and 25 percent protein (Moyle 1961). Johnson (1971) reported that a deficiency of natural foods high in protein not only hinders growth in wood duck ducklings, but may also increase mortality by causing an extension of the flightless period, rendering the ducklings more susceptible to the effects of diseases, predation, weather, and other limiting factors. Arner et al. (1974) have shown that a greater quantity of invertebrates available to nesting wood ducks not only contributes to greater numbers of both young and adult birds, but also may have a positive effect on the population's clutch size. Krull (1970) states that it is becoming sufficiently evident that egg-laying hens, ducklings, and molting adults cannot obtain their necessary protein requirements entirely from aquatic plants. He concludes that aquatic invertebrates must fulfill the role.

Several studies have indicated that the largest standing crops of invertebrates are associated with submerged aquatic plants possessing finely dissected leaves (Moyle 1961 and Krull 1970). In our studies *Ceratophyllum demersum* and *Cabomba caroliniana* produced large standing crops of invertebrates when they were encountered in dense mature stands; however, both of these plants, as well as most submerged aquatics, do not become well established in most southern water until after flooding and resulting turbidity have subsided in late spring or early summer.

The largest average yield of invertebrates during the three year spring sampling period was observed in a *Ceratophyllum* community in 1968 (230.88 kg/ha); however, during the spring of 1970 this plant did not recur until after the spring sampling period had ended in mid-May (Figs. 2 & 3). In 1973, *Ceratophyllum* recurred in March at one sampling location and in mid-May at another. However, in both locations, the stands were sparsely scattered and produced meager invertebrate standing crops (38.36 and 41.16 kg/ha respectively).

The importance of a particular plant community to breeding waterfowl may lie not only in the quantity of invertebrates the hydrophyte harbors, but may also depend upon the time of year at which the community appears. Wood ducks are known to nest in Mississippi as early as the first week in February. However, the majority of nesting begins in March and April (Cummingham 1969, Baker 1971, and Teels 1975). Thus, late winter and early spring appear to be the most critical time with respect to protein demand of nesting hens with the greatest demand of ducklings occurring several weeks later. Therefore, in evaluating a plant with respect to its ecological and physiological value to

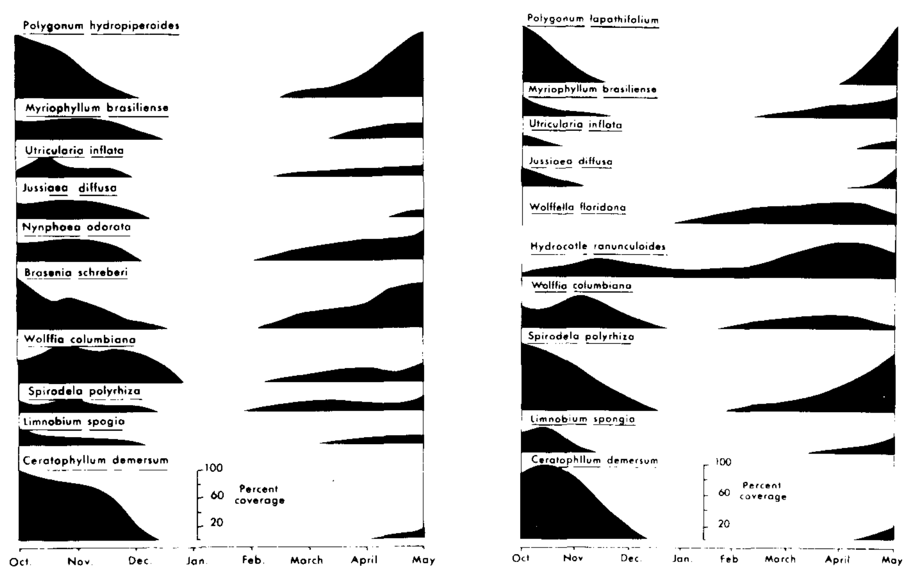


Figure 2. Estimated coverage and periodicity of aquatic plant species in Mississippi, 1969-70.

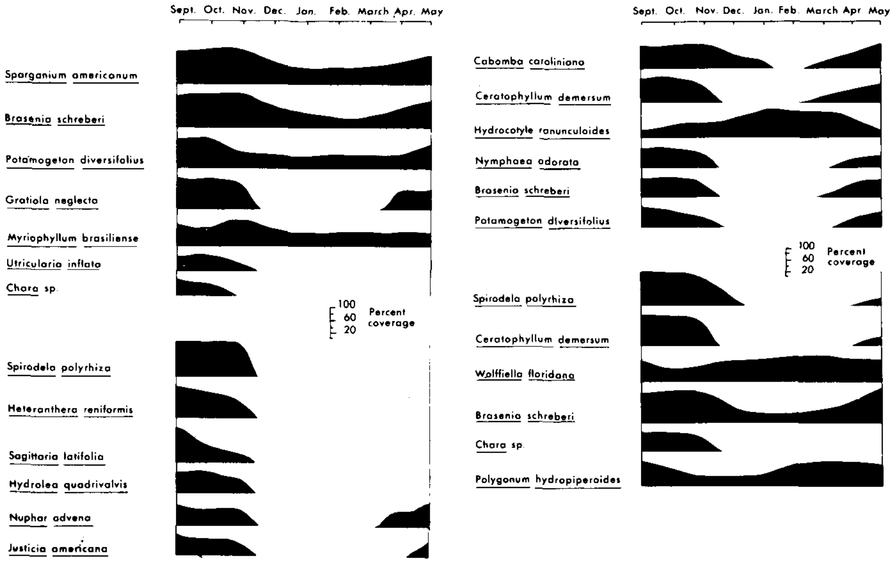


Figure 3. Estimated coverage and periodicity of aquatic plant species in Alabama and Mississippi, 1972-73.

breeding waterfowl, consideration must be given to its characteristic periodicity as well as invertebrate production. It is felt that *Ceratophyllum* and a number of other submerged aquatics fall short in the role of supplying the needed invertebrates to nesting wood ducks and their broods during the time of demand. Submerged aquatics also possess shortcomings in that the invertebrates they harbor are often inaccessible to surface feeding ducks and ducklings.

During 1969-70 and 1972-73, two plants were encountered during the winter and persisted throughout the spring (Figs. 2 & 3) and contained significant amounts of invertebrates (Table 1). The species, *Hydrocotyle ranunculoides* and *Wolffiella floridana,* were considered important in developing and maintaining high wood duck densities in areas in which they were encountered (Arner et al. 1974, Teels 1975).

*Ranunculoides* appears to be a cool weather plant which increases in abundance after frost has eliminated competition of other aquatic vegetation (Figs. 2 & 3). It occurs as a shallow water emergent or in floating mats at various water depths. The leaves and stems are extremely succulent and appear to attract a great diversity and standing crop of invertebrates (Table 1). *Ranunculoides* seems to prefer natural wetlands with fertile soils, being very common in the Mississippi River alluvial floodplain and occurring only occasionally elsewhere. The growth habits of this plant expose invertebrates at the water's surface to a few centimeters above, making the invertebrates it contains extremely accessible to feeding waterfowl.

*Floridana,* likewise, is a cool weather plant persisting after other plants have disappeared (Figs. 2 & 3). It is a free floating form which also appears to prefer the nutrient rich water common in natural lakes of the Mississippi River alluvial floodplain and other large river basins. Its standing crop of invertebrates is considered lower than that displayed by *Hydrocotyle* but comparable to that of other duckweeds (Table 1). Its floating growth habit also enhances the availability of invertebrates to surface feeding ducks and ducklings.

It is felt that *H. ranunculoides* and *W. floridana* may possess qualities that would lend themselves to applied management. By introducing these plants in areas where forage

Table 1. Average wet weights of invertebrate standing crops in the more commonly occurring aquatic plants sampled during the spring months (kilograms/hectare).

| Plant Species | *Invert. Standing Crop (Kg/ha)* | | |
|---|---|---|---|
| | *1968* | *1970* | *1973* |
| *Brasenia schreberi* | 36.16 | 86.11 | 12.42 |
| *Cabomba caroliniana* | 129.98 | — | 168.72 |
| *Callitriche herterophylla* | 69.99 | 27.01 | — |
| *Ceratophyllum demersum* | 230.88 | * | 39.76 |
| *Eleocharis quadrangulata* | 40.73 | 24.26 | — |
| *Hydrocotyle ranunculoides* | — | 182.65 | 191.56 |
| *Myriophyllum brasiliense* | 43.74 | 55.17 | 43.65 |
| *Nymphaea odorata* | 9.97 | * | 3.50 |
| *Polygonum hydropiperoides* | 30.79 | 41.54 | 55.55 |
| *Potamogeton diversifolius* | 40.73 | — | 61.13 |
| *Spirodela polyrhiza* | 36.49 | 145.92 | * |
| *Wolffiella floridana* | — | 69.05 | 55.26 |

– Species not encountered during that particular study.
* Species not reappearing during the spring (March, April, May) sampling period.

during the breeding season is sparse or absent, it is conceivable that increased wood duck densities may result. Lakes and ponds containing wood duck boxes, but no aquatic vegetation would lend themselves particularly to this application if soil conditions and water quality would permit.

Both *Hydrocotyle* and *Wolffiella* occur in wetland types with relatively stable water levels and in wetlands which are void of trees or contain sparse canopy cover. Although extensive stands of these species may occur in spring, usually by mid-summer, densely vegetated areas have succumbed to climate, insects, disease or competition from warm-season aquatic plants, restricting the *Hydrocotyle* and *Wolffiella* communities to only a few scattered stands. In most cases, 100 percent coverage of the wetland is not approached if there is any water which is either deep or open. Extensive stands of *Hydrocotyle* appear to be limited to shoreline areas where roots are able to attach to the substrate. *Hydrocotyle* also occurs in floating mats, but these are generally small (less than 10 meters in diameter), scattered, or completely absent if exposed to wave action. *Wolffiella*, being a floating leaf form, is also extremely limited by wave or wind action and generally occurs only in wetlands surrounded by trees or shrubs which suppress the effects of wind.

Due to their growth characteristics, it is extremely doubtful that the presence of *Hydrocotyle* or *Wolffiella* would seriously interfere with other water-based recreation or use. Their presence, in fact, may greatly enhance other water related activities. Fishing, for example, appears to be improved by *Hydrocotyle* in a beaver pond area adjacent the Tombigbee River near Columbus, Mississippi. Here, *Hydrocotyle* furnishes shoreline cover to early spring large-mouth bass (*Micropterus salmoides*) which seek out fringe areas of the plant community or hide beneath the floating mats.

The invertebrates provided by *Hydrocotyle* and *Wolffiella* are valuable foods to many aquatic organisms. Most species of fish utilize aquatic invertebrates as either a primary or supplemental source of protein. Other classes of invertebrates have aquatic members which depend to varying degrees on the aquatic plant-invertebrate relationship. Thus, the presence of *Hydrocotyle* and *Wolffiella* during periods when no other food or cover exists enhances other aquatic resources as well as breeding waterfowl and their broods.

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