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PERENNIAL CROP-BASED AGROFORESTRY SYSTEMS IN NORTHEAST BRAZIL*

By

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ABSTRACT

Land use systems in the Northeast Region of Brazil are dominated by large holdings and extensive cultivation of perennial crops such as cashew, coconut, carnauba wax palm, babacu palm and so on. The common feature which links these crops is the silvopastoral system of livestock (chiefly cattle, sheep and donkeys) grazing under them. Agrosilvicultural systems involving cultivation of annual subsistence crops, and in some instances other perennials, in the stands of these perennial crops is also common. The paper presents the available information on the management, production, rate of growth, economic importance, etc. of these agroforestry systems involving cashew, coconut and carnauba palm.

These systems are of considerable merit in the environmental, agricultural and socioeconomic conditions of Northeast Brazil. However, practically no research nor even systematic data collection has been done on these so that there is an almost total lack of information on them. In order to improve the systems, they should be studied in detail and research undertaken on various components (crops, trees and livestock) individually as well as the system as a whole.

Selection of suitable species of grass and other herbaceous crops, appropriate management techniques for both overstorey and understorey species in relation to the age of the overstorey species, optimal stocking rates of animals, etc. have to be determined so as to enable plantation owners and operators to realize the full potential of these systems.

Key words: Agroforestry, Carnauba, cashew, coconut, Northeast Brazil, Silvopastoral systems.

1. INTRODUCTION

Perennial cropping systems are found throughout the Northeast Region of Brazil, under a wide range of rainfall conditions. Since the earliest period of Portuguese colonization, the Northeast has also been characterised, especially in the interior, by extensive livestock grazing. In the present century, agriculture has become more intensive as a consequence of the burgeoning human population of the region and increasing opportunities for agricultural exports. This has resulted in a trend toward combining certain perennial crops and livestock grazing into definable silvopastoral and other forms of agroforestry systems. The major perennial crop components of these systems are cashew *(Anacardium occidentale)*, coconut *(Cocos nucifera)*, babaçu palm *(Orbignya oleifera)* cacao *(Theobroma cacao)* carnauba wax palm *(Copernicia cerifera)* and African oil palm *(Elaeis guineensis)*.

To-date, only a modest amount has been published about agroforestry systems involving these plantation crops. Of these, coconut-based systems have received the most attention. Coconut intercropping systems have been studied and reported from India (7, 9, 10), Sri Lanka (6) and cattle and grazing under coconuts from the Far East and the South Pacific (12, 13, 14, 15, 16). Warui gave a brief account of the crop combinations with cashew and other perennial crops on the Kenyan coast in East Africa (18). Torres has mentioned the viability of the practice of cattle grazing under cashew and coconuts (17). But none of these reports contains any information on the systems in Brazil.

The purpose of this paper is to describe some subtypes of the agroforestry (mainly silvopastoral) systems in the Northeast of Brazil. Cacao-based systems in Bahia State and Babacu-based systems in Maranhão

State are being studied in greater detail by researchers in the two respective research institutions and those systems will be described later in separate contributions to this Series. Information on oil palm-based systems is too fragmentary to be reported. Therefore, this paper concentrates on the systems based on cashew, coconut and carnauba wax palm.

2. GENERAL DESCRIPTION OF THE AREA

The Northeast Region of Brazil has a land area of over 1.5 million km^2 and extends over tropical and equatorial latitudes from 18^oS in the State of Bahia to 1^oS in the State of Maranhão. Although representing only about 18 percent of the national territory, it contains approximately 30 percent of Brazil's 125 million people.

Precipitation is the key environmental factor of ecological significance for the region and can be characterised by three major zones trending northeast to southwest. First is a narrow humid coastal strip in the east which receives an average of 1250 mm to over 2000 mm of rainfall per annum. Second is a middle zone of moisture deficiency which accounts for the largest portion of the Northeast. Most of this zone receives less than 1000 mm of annual rainfall, with an extreme low of less than 300 mm in one small area. The third zone is one of high rainfall, over 2000 mm per year, in western Maranhão. Reflecting this wide diversity of moisture conditions are natural vegetation patterns ranging from tropical rainforest to semiarid thorn scrub.

Given such a large land area, only very broad generalizations can be made about soils. FAO Soils Map of the World shows that the region is dominated by highly weathered, leached Luvisols, Ferralsols and Acrisols,

with dry sandy Arenosols and Regosols common along the coast (1). Topography in those locations where cashew, coconut or carnauba occur or are cultivated is nearly flat.

Land use systems in the Northeast are dominated by large holdings, a pattern which has its origins in the early land grants received by Portuguese colonists. In coastal areas, land was most often devoted to sugarcane monoculture, whereas in the interior large livestock ranches were the rule. Traditionally, beef cattle have been driven to the better-watered coast during the long dry season in the interior. Recently-harvested sugarcane fields, as well as areas of cashew, coconut or carnauba had been used for such seasonal grazing. Even with the modernization of perennial crop agriculture in the present century, these systems have been retained because of their benefit to both the land-owner and the cattleman. Increased raising of dairy cattle along the coast is also associated with plantation agriculture. Along with the improvement of perennial crops themselves has come the improvement of cattle breeding stock and the cultivation of better grass species for planting beneath the tree crops. Fig. 1 shows a sketch map of Northeast Brazil showing the areas where the system(s) being described here can be found.

FIG. 1 HERE

3. STRUCTURE OF THE SYSTEM

The common feature which links cashew, coconut and carnauba is livestock grazing (silvopastoral system). Cultivation of annual subsistence crops and in some instances other perennials in the stands of these perennial crops (agrosilvicultural system) is also common.

Both cashew and carnauba are native to Northeast Brazil and wild stands have a long history of exploitation. The Portuguese introduced the coconut to coastal Brazil during the 16th century where it quickly became naturalized. Thus under conditions of subspontaneous growth it is equivalent to the stands of the two native species. In addition to gathering the economic products of these three trees, the land areas they occupy are also traditionally used for other agricultural purposes. Locally-raised livestock -- chiefly cattle, goats and donkeys -- are grazed on spontaneous grass and shrub growth beneath the trees and, as already mentioned, so are cattle brought in from the interior for seasonal grazing, and these tree stands provide the much-needed shade to the livestock. Livestock are removed from the fields during the harvesting of cashew fruits and carnauba palm leaves. Fig. 2 shows a coconut plantation with spontaneous grasses, typical of the type used for cattle grazing. Fig. 3 is of a natural stand of carnauba palms with grazing of donkeys. Crowns of the palms are sparse because of leaf harvest.

FIG. 2 AND FIG. 3 HERE

It is also a common practice to clear small plots within the stands of trees to plant subsistence crops during the annual rainy season. Typically, maize, beans and cassava are grown. Individual plots are fenced to keep the livestock out; however, once the crops have been harvested they are allowed to browse on the stubble.

Under formal plantation cultivation of cashew, coconut or carnauba, the components are slightly modified. Basically the change involves cultivation of subsistence catch crops between the rows of trees for the first few years of their growth. Once again, maize, beans and

cassava are the rule. On very large holdings which are mechanized, industrial catch crops such as grain sorghum, peanuts, sesame *(Sesamum indicum)* or cotton are planted. This industrial catch cropping is most often found on cashew plantations. The choice of a particular crop depends upon environmental conditions and the presence of local demand for the commodity.

Once catch cropping is phased out as the trees increase in size, spontaneous grasses replace them or pasture grasses are planted as permanent ground cover. Native ginger grass *(Paspalum maritimum)* and African Guinea grass *(Panicum maximum)* have proven to be successful on cashew plantations (5). Thus in contrast to what occurs with native stands, when these perennial crops are formally cultivated, grazing replaces annual cropping after a few years, rather than coexisting with it.

Occasional intercropping of cashew, coconut or carnauba with other perennial crops is also practised in the region. But this represents a variation of the system where the high planting densities of the main crop exclude livestock and annual cropping. For example, in southern Bahia, there is limited use of coconut to provide cacao with shade and protection from wind. In the elevated areas of Pernambuco where coffee is grown, some older plantings are shaded with cashew trees (Fig. 4). Reportedly in Ceará, cashew trees are utilized to provide support for pepper vines. On very small farms one can see coconut and cashew, cashew and citrus, and cashew, banana and coconut interplanted. Carnauba is not found in association with other perennial crops.

FIG. 4 HERE

4. SYSTEM FUNCTIONING

In Brazil too, like in nearly every other country, agricultural statistics are reported separately under headings of annual crops, perennial crops and livestock. Moreover, statistics are also published on the quantities of products gathered from wild plants in Brazil. Cashew is included as both a perennial crop and a gathered product, coconut as a perennial crop only, and carnauba as exclusively a gathered product. Under such circumstances it is impossible to determine the area of the respective crops which is currently associated with livestock grazing, or the degree to which intercropping of annual crops exists. Nevertheless, the statistics available on perennial crops can be examined to gain a rough idea of the situation. The figures cited in the following discussion are from FIBGE (2, 3).

In 1980, an area of 184,151 ha was enumerated for cashew plantations in the Northeast. Also that year, 18,387 t of unshelled nuts were gathered from natural stands. Conservatively, a cashew tree in Brazil yields about 2 kg of nuts per year. Thus 9,193,500 trees can be estimated to have provided the total. Using the common plantation density equivalent of 100 trees per ha, this would represent 91,935 ha. Therefore 276,086 ha of cashew trees can be used as an approximate total. The coastal areas of Ceará and Rio Grande do Norte states account for more than 70 percent of this national total (Fig. 1). In addition to the cashew nuts which furnish high-value kernels and the industrially valuable cashew nut shell liquid, the fleshy peduncle or apple of the fruit supports small local industries which produce juice and several types of preserves for the domestic market. Kernels and shell liquid are exported.

The area under coconut is less complicated to determine, and in 1980

totalled 164,779 ha for all of Brazil. Over 60 percent of Brazil's total production of coconuts is from the coastal strip, about 50 km wide, in the states of Alagoas, Sergipe and Bahia (northern parts) (Fig. 1). About 10 percent occurs outside the Northeast Region. On the average, a coconut palm yields 25-30 nuts per year in Brazil. Green coconuts are harvested for direct consumption of coconut water as a beverage. Mature nuts support an industry which produces coconut milk and grated coconut; copra is not made. Locally the palm leaves are utilized for thatching and fencing. Brazil does not export coconut products.

As far as the carnauba palm is concerned, no statistics on area are available, although the stands of native trees are estimated to number in the hundreds of millions. Major concentrations are to be found in the river valleys and coastal lowlands of Piauí, Ceará and Rio Grande do Norte (Fig. 1), which account for more than 90 percent of the carnauba wax produced in the country. An indeterminable number of palms have been planted, at densities of 800-1200 per ha, but the practice apparently ended in the 1950s. The palm furnishes two economic products: wax from the leaf surface which has many industrial uses, especially in the food industries because it is edible; and leaf fibre which is the raw material for a small, exclusively domestic, cottage industry of making hats, baskets, etc. In 1980, wax production amounted to 18,857 t, all from the Northeast. At a wax yield of 5 g per leaf, and each tree providing 20 leaves per year, a single palm would produce 100 g (4). Thus 1980 production involved 188,570,000 palms. Wax has been a Brazilian export since the middle of the 19th century. Carnauba leaf fibre production in 1980 was reported to be 1398 t. Although no statistics are collected, carnauba wood is widely used in the Northeast for construction purposes.

According to information obtained in the field, livestock raising is most often found in associations with cashew, coconut or carnauba on large landholdings. On cashew plantations, grazing is not practised the year around; cattle tend to be found in coastal areas, goats in the interior. Smallholders typically do not have the capital to invest

in cattle, but may run a few head of goats or donkeys and an occasional hog or two. No information on stocking rates for plantation grazing is available. Plucknett states that the carrying capacity of one hectare of coconut plantations in Sri Lanka is 1.25 to 5 head of small Sinhala cattle (12).

In socioeconomic terms, these three perennial cropping systems are quite labour intensive, but only on a seasonal basis. Harvesting of cashew nuts and apples, coconuts and carnauba leaves is all done by hand, as is a significant portion of the subsequent processing. Fortunately for these agroindustries, Northeast Brazil has a sizeable rural populations which does seasonal harvest labour to supplement their income as subsistence-level farmers.

6. SYSTEM DYNAMICS

Over the past few decades, each of these three tree crops has experienced different rates of change. Area under cashew has increased considerably due to the establishment of large-scale plantations. Before the Brazilian government initiated a major programme to encourage cashew cultivation in the late 1960s, there were probably no more than a few thousand hectares under actual plantation conditions, and prior to that, virtually all of the cashew nuts came from natural stands. The new programme proved to be a powerful stimulus to agri-business and led to the establishment of some 180,000 ha of modern cashew plantations, most of which were at a density of 100 trees per ha. Many of the new plantations are engaged in catch cropping of subsistence and industrial crops, and some have subsequently converted the areas to pasture for grazing.

Below-average rainfall during the period 1979-1983 led to some losses

of cashew trees, particularly on plantations in areas of poorer soil. Not unexpectedly, insects and diseases affecting cashew have also become more serious. These factors have prompted a period of retrenchment with plantations placing greater emphasis on cattle raising. In order to make that more feasible, new plantings are at a density of 51 trees per ha to allow more open area for grass growth. On some plantations, the earlier more dense plantings have been thinned. The state of cashew cultivation today is difficult to generalize because on the one hand, some plantations are without livestock, whereas there are establishments which have livestock as a primary objective and cashew growing as a secondary activity, on the other.

Area under coconuts has also undergone a strong and steady expansion. From 73,583 ha in 1960, it increased to 117,193 ha in 1970 and to 164,779 ha in 1980. Currently the Brazilian government has a major programme under way to encourage the establishment of new large-scale plantations of coconut, which although focussed on the Northeast, also includes the Amazon Region. Part of the programme is to make available improved coconut varieties, including dwarfs, for the new plantings as well as for the needed replacement of older plantings. Since this programme involves large holdings almost exclusively, there exists the potential to expand the practice of plantation grazing.

Quite a different pattern is found with regard to the carnauba palm. Wax production, which stood at 10,982 t in 1960, nearly doubled to 20,378 t in 1970, but declined in 1980 to 18,857 t. The major reason for this decrease is attributable to the substitution of artificial waxes for carnauba in many of its nonfood uses. However, this decline in production does not reflect any decrease in the number of palms. When demand for wax is slack, the trees are simply not harvested.

Some minor losses of palms do occur when land is cleared for other purposes, but since the carnauba's native habitat is on poorly drained sites and flood-plains, there is minimal conflict of land use. Moreover the palms reproduce vigorously.

The performance of the perennial crop-based system appears to be favourable in the case of cashew and coconuts, but marginal for carnauba because of economic factors. Even without much wax harvesting, however, the multiple utility of the carnauba and its compatibility with grazing and annual cropping assures a continuation of the subtype. High demand for meat on domestic and foreign markets has made livestock more and more attractive to agri-business concerns. In fact, properly managed livestock raising on plantations should increase their sustainability and avoid over-reliance on a single commodity.

7. EVALUATION

The system discussed in this paper has considerable merit in the context of the environmental, agricultural and socio-economic conditions in Northeast Brazil. From an environmental standpoint, establishment of new plantations of cashew or coconut represents an upgrading of the vegetative cover in most areas of occurrence, from what currently exists. There is a strong justification for protection of native stands of carnauba because of their multiple utility. Plantation grazing is an environmentally sound practice, and adheres to the general recommendation that grazing is a preferred system for the dry savanna climates characterizing so much of the Northeast (8).

Agriculturally, the diversity of this perennial crop-based agroforestry system offers the advantage of making more efficient use of labour and equipment over the entire calendar year, thereby avoiding the peaks and

slacks of activity associated with monoculture. Plantation grazing does however have a few disadvantages too. Careful management practices must be followed to prevent animals from physically damaging young trees. Moreover, when natural stands are utilized, such as with the carnauba, grazing may, over time, hinder natural replacement of trees due to browsing on young leaves and trampling of seedlings. Livestock grazed beneath cashew trees can eat unutilized cashew apples, but excessive quantities should not be allowed because of their high tannin content. Domestic animals also feed on the small carnauba fruits which fall to the ground. There is no general agreement among agronomists as to the advisability of grazing on plantations. Ohler (11) recommends against it, though from a rather narrow monocultural viewpoint. Plucknett views grazing on coconut plantations as an acceptable practice, and one which especially benefits smallholders (12). Similar results have also been reported from studies in the Solomon islands (13, 14, 15, 16). With respect to Northeast Brazil, the long tradition of a variety of successful grazing systems cannot, in any case, be ignored.

There are a number of socioeconomic benefits from this system in the Northeast. The international market for cashew kernels is strong and elastic, and good potential exists for increased domestic utilization of the cashew apple. Coconut products enjoy high demand within the country, which is providing an incentive for expansion of the crop. The future of carnauba wax as a raw material is not very promising. Apparently international markets are undergoing an adjustment which will likely stabilize demand at a level below current production. Economically, livestock raising is profitable in the Northeast, and the combining of it with cashew or coconut should strengthen the economic base of the individual plantation.

In social terms, the growth of agro-industry in the region creates new industrial employment. Given the large rural labour pool, there is not a strong incentive to mechanize plantation operations. In the rural areas, local inhabitants also benefit to a degree from having free or very inexpensive sources of thatch, wood, etc. from the plantations. Social reasons may, in fact, be the overriding justification for encouraging the expansion of perennial-crop based systems.

8. RESEARCH NEEDS

It is obvious from the above description that although the system is practised over extensive areas and it has a number of merits, there is an almost total lack of information on its various management details. Practically no research, not even systematic survey and data collection, has been done on the system, so that no quantitative information is available on many, if not any, of the basic aspects. Therefore the first essential step in improving the system will obviously be to collect quantitative information on the functional and dynamic aspects. These should include current levels of production of various components, as well as the rate of change of production of components with time. It is important to note that not only will the production of grass or other understorey species vary depending upon the age (and consequent interaction effects) of the overstorey species, but also the pattern of production of components of the system at a given growth stage or age of the overstorey species would have changed over a span of few years in a region. Once these data are assembled, the logical next step will be to examine the reasons for the observed behaviour and see how the efficiency of production could be improved. This will involve research on a large number of management aspects of the individual components as well as of the system.

The role of livestock in this system needs to be studied in more detail. Research must be conducted to ascertain optimal stocking rate, which, in turn, will involve all the related aspects such as the species of grass, the type and breed of livestock, management of overstorey and grass species and so on.

Plantation owners and operators need to have better general and crop/site-specific management techniques so that the full potential of this system can be realized.

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LIST OF FIGURES

Fig. 1: Map of Northeast Brazil showing the major areas where agroforestry systems involving cashew, coconuts and carnauba wax palm exist.

Fig. 2: A cultivated coconut plantation near Aracaju, Sergipe with spontaneous grasses, typical of the type used for cattle grazing.

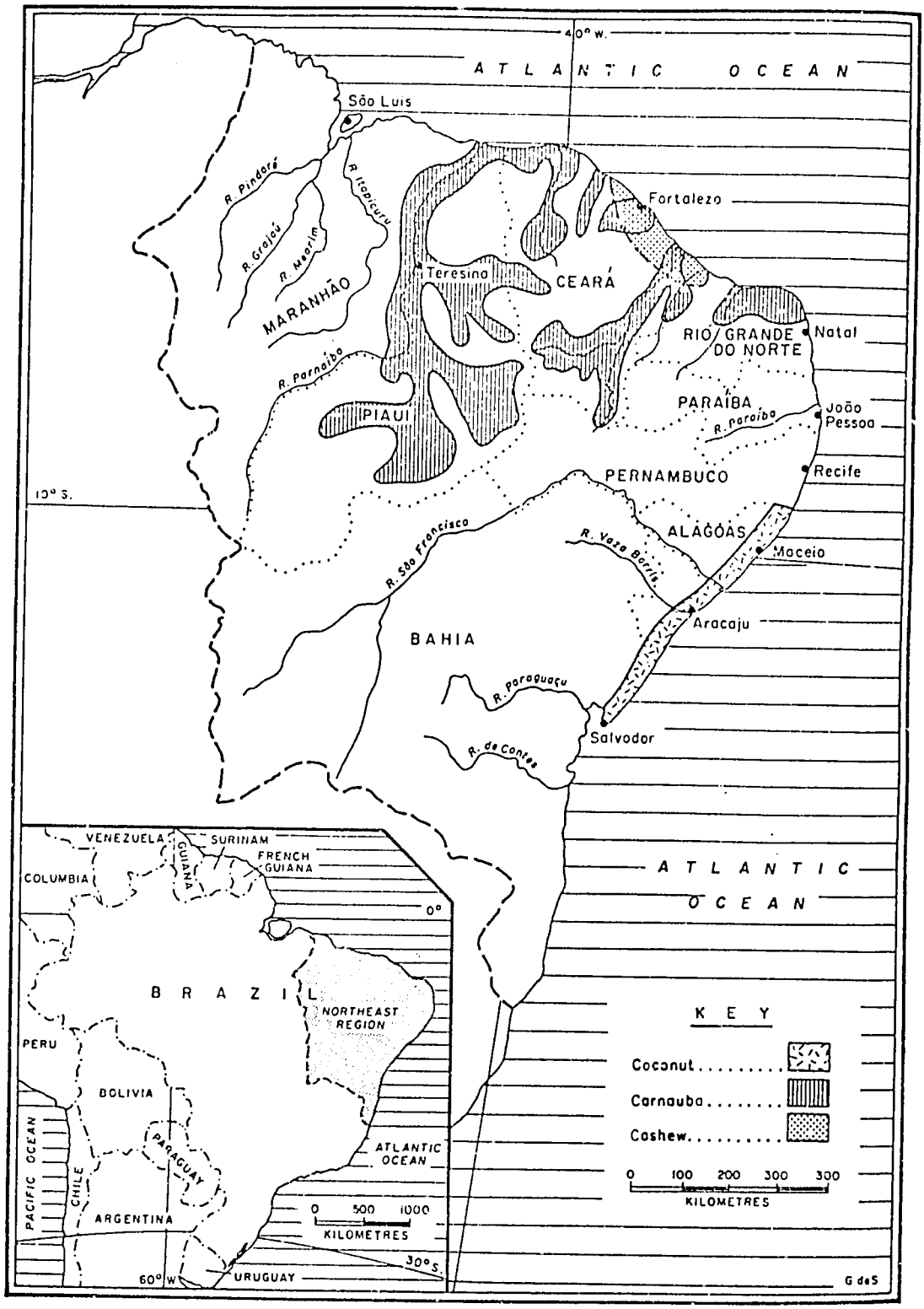
(Photo: D.V. Johnson)

Fig. 3: A natural stand of carnauba wax palms near Fortaleza, Ceará, with grazing of donkeys. The palm crowns are sparse because of leaf harvest.

(Photo: D.V. Johnson)

Fig. 4: Agroforestry system of growing coffee under the shade of cashew on a farm near Garanhuns, Pernambuco, Brazil.

(Photo: D.V. Johnson)



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