SOUTH FLORIDA RESEARCH CENTER

Report M-649
The Status of the Schaus Swallowtail and the Bahama Swallowtail Butterflies in Biscayne National Park

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ABSTRACT

Surveys of the Schaus swallowtail and Bahama swallowtail butterflies, both federally-listed threatened species, were undertaken during 1979 and 1980. The survey was continued by Biscayne National Park personnel during 1981. Transects were routinely monitored on several keys in Biscayne National Park to determine the numbers of adults present, to delineate the emergence season and distribution, and to identify factors which affect their status. The population size of the Schaus swallowtail on the keys was small during 1979 and 1980, but adults were widely distributed in suitable habitat. Emergence season was similar in both years, occurring from late April to late June. Numbers of the Schaus swallowtail were lower on the 1981 surveys, and the emergence period seemed to be retarded. The Bahama swallowtail was not observed during the surveys, and its existence in the Biscayne National Park is doubtful. Data on cohabiting lepidopterans was collected and is presented here.

It is recommended that the Bahama swallowtail be deleted from the Federal List of Endangered and Threatened Species because recent evidence of an established breeding population is lacking. If the present trends in range contraction and decline in population size continue, the Schaus swallowtail should be elevated from threatened to endangered species status. Future research recommendations for the Schaus swallowtail include the establishment of a captive breeding stock, reintroduction into suitable habitats in the Florida Keys, continued surveys of existing colonies, and an investigation of the effects of environmental, biotic, and human factors on all life stages of this species.

INTRODUCTION

The Schaus swallowtail (Papilio aristodemus ponceanus) was first described at the turn of this century from the Miami area (Schaus 1911). It was eliminated from the Miami area as the city developed, but was re-discovered further south on the Florida Keys. This butterfly received much attention following the 1935 hurricane because of a report of its expirpation on the keys by the storm (Grimshawe 1940). Interestingly, Grimshawe continued to advertise specimens for sale in entomological journals following this report. Henderson (1945a, b) later documented the continued existence of Schaus swallowtail in the keys. By this time, the butterfly had become a glamour species in great demand by collectors and during the next two decades both Klots (1951) and Kimball (1965) noted the potential for over-collecting of this rare species. In 1972, Covell and Rawson (1973) and Brown (1973) independently surveyed the Upper Keys, including those within Biscayne National Park. They found that the Schaus swallowtail was well-established in the park area, and Brown (1973) reported seeing 100 adults in a day. From 1973 to 1976, Covell (1977) continued to survey this species on the keys of Biscayne National Park and found a decrease in numbers from the levels of 1972. He speculated that this decrease may have resulted from winter drought conditions which inhibited new growth on the larval food plants during those years. Limited surveys were conducted during 1977 and 1978 with few adults being observed on the keys in the park (James Tilmant, pers. comm.).

The Bahama swallowtail (Papilio andraemon bonhotei) has been recorded from southeastern Florida and the keys on several occasions during this century. These records were thought to represent casual and sporadic dispersal from the Bahamas rather than being the result of successful colonization and breeding by the species in Florida (Brown 1973). Only on two occasions has the existence of a breeding population been suggested. The collection of a fresh adult in Florida on Long Key was used to support this contention (Kimball 1965), as was a more recent report of large numbers of adults, including ovipositing females, on the keys in Biscayne National Park (Brown 1973).

The two swallowtail butterflies became the first invertebrates to be included on the Federal List of Endangered and Threatened Species. The overlapping range of these threatened butterflies in the United States is limited to tropical hardwood hammocks of the Upper Florida Keys, including those in Biscayne National Park, where environmental conditions are suitable for hammock growth. Such hammocks are normally found on the highest land in south Florida and often occur near the coast. The rapid urban and commercial development in south Florida and the keys has occurred in these same areas, resulting in the loss of extensive areas of hammock. This destruction has proven devastating to the butterflies, especially because their population sizes and ranges in Florida appear to have been small under natural conditions.

Little biological data existed for these butterflies at the start of this study. The purpose of the present study was to determine the status and distribution of these species on the relatively undisturbed keys in Biscayne National Park, to document the season and the duration of adult emergence, to confirm the larval food plants, and to define those factors which affect the status of the butterflies.

STUDY AREA

Two islands in Biscayne National Park were chosen as sites for monthly transects because of the mature hardwood hammocks present there. Many swallowtails had been sighted within these hammocks in past years. On Elliott Key, during the past decade, an approximately one kilometer transect was established south of Billy's Point, near Petrel Point (Fig. 1). The route crossed the island from the ocean to the bay through mature hammock, included a portion of the cleared Spite Highway, and looped southward into a hammock on the bayside. The transect included large stands of the known larval food plants, torchwood (Amyris elemifera) and wild lime (Zanthoxylum fagara), and an old grove of key limes (Citrus aurantifolia), the reported larval food plant of the Bahama swallowtail (Klots 1951).

The transect on Old Rhodes Key was an approximately one kilometer loop through a mature hammock on the southern tip of the key (Fig. 1). This hammock had an unbroken canopy, except where trees had fallen, and contained large numbers of torchwood and wild lime trees.

On the 1980 surveys, additional monthly visits were also made to an abandoned key lime grove at the northern tip of Totten Key (Fig. 1). The lime trees were intermixed with encroaching hammock species which resulted in a more open habitat than in a mature hammock.

METHODS

The transects on both keys were monitored on the same day each month from late March to late September in 1979 and 1980, except for March 1979 when boat trouble precluded the monitoring of Elliott Key. In 1981, biweekly surveys along the same transects were continued by Biscayne National Park personnel. Each transect required from two to three hours to survey. The survey was made only on sunny days when butterflies would be expected to fly. During the emergence period, surveys were increased to twice per month to determine the timing and duration of emergence.

The survey method involved walking slowly along the route with frequent stops to scan the surrounding hammock for butterflies. The weather conditions at the time of survey were noted and all butterflies were counted and recorded. An attempt was made to avoid recording an individual butterfly more than once. In addition, torchwood leaves were checked for eggs, larvae, and feeding signs during the surveys. During the emergence period of P. aristodemus ponceanus, the number, condition, and behavior of the adults were observed. By noting the condition of the few specimens present (i.e., the number of tails missing, notches in the wings), it was possible to recognize individual Schaus swallowtails along the survey route, and to obtain an accurate count of individuals.

RESULTS

Schaus swallowtail

In 1979, P. aristodemus ponceanus adults occurred on the transects on the survey of 24 May. Seven specimens were found on the Old Rhodes Key transect and five adults along the Elliott Key transect. All of the adults on Elliott Key occurred in

the bayside hammock. Another specimen was seen at the Elliott Key Marina on 22 May by Dennis Leston and Barbara Rivera (pers. comm.). No adults were present on the 12 April survey, so that emergence occurred between that date and 22 May. Dry conditions prevailed on the Keys until 20 April, when torrential rains fell. Judging by the dull, tattered appearance of the adults on 24 May, it appears that emergence closely coincided with the rains. No adults were seen on the 19 June survey, nor on subsequent surveys in 1979.

In 1980, the first adults appeared about 28 April (Gerold Morrison, pers. comm.). During a survey on 5 May 1980, two adults were found on Elliott Key (Table 2) and two on Old Rhodes Key (Table 3). There was no evidence of larval feeding on torchwood, with the exception of one larva of P. cresphontes. On 20 May, two Schaus swallowtails were observed on Elliott Key and four adults on Old Rhodes Key. On the 5 May survey, the adults appeared fresh and newly emerged but, by 20 May, they were beginning to look tattered. No adults were seen on Old Rhodes Key on 23 June but two old individuals occurred on Elliott Key. Both were quite tattered and dull, having lost most of their wing scales.

On 23 June the lime grove on Totten Key was surveyed, and for the first time in 1980, Schaus swallowtails were found on that key. Two freshly-emergent adults were circling one another in courtship when a third fresh adult flew in. The three butterflies moved off into the hammock. This was the final sighting of adult Schaus swallowtails in 1980. The survey was continued until September in an attempt to document any additional emergences of adults, but no adults were observed after the 23 June survey.

In 1981 no adult Schaus swallowtails were observed until 13 May, with two adults on the Elliott Key transect and none on Old Rhodes Key. On five subsequent biweekly surveys, the park personnel recorded only one adult on Old Rhodes Key, and seven adults on Elliott Key. The last sighting of adult Schaus swallowtails occurred in mid-August 1981 (Daniel Peters, pers. comm.).

In 1980, photographs of a Schaus swallowtail larva on torchwood were taken. Very few larvae were found along the transects despite much searching. Larvae which have been followed through several instars often disappear from the host plants after several days of observation (Morrison 1981), indicating high mortality in the early life stages. The causes of larval mortality, whether from predation, disease or adverse environmental conditions, require investigation to better understand the population dynamics of the Schaus swallowtail.

Bahama swallowtail

In spite of much searching in 1979 and 1980, P. andraemon bonhotei was never observed on the keys of Biscayne National Park. Brown (1973) reported numerous adults on the keys of Biscayne National Park during May so that the survey times were made to closely coincide with the dates of his sightings. The survey routes passed through old groves of key limes, the larval food plant, and if this butterfly was present in the park, it would likely have occurred in those areas. Two other workers were observing butterflies on the keys at the time of our surveys, Dennis Leston in 1979, and Gerold Morrison in 1980, and neither saw the Bahama swallowtail (pers. comm.). In 1981, no Bahama swallowtails were seen on either key (Daniel Peters, pers. comm.; pers. observ.).

Additional lepidopterans

During the surveys of the swallowtails, other lepidopterans along the transects were recorded (Tables 1, 2, and 3). In 1980, individuals of each species were also counted. Fourteen species were observed on Elliott Key in 1979 compared with nineteen species in 1980. On Old Rhodes Key, eleven species were found in 1979, and the same number in 1980. On Old Rhodes Key fewer species were present on a given day than on Elliott Key.

DISCUSSION

Bahama swallowtail

The sole record for this species in recent years in Florida comes from Brown (1973). He reported approximately 100 adults on Elliott Key in April and May 1972, and observed females ovipositing on Citrus sp. trees. Previous reports of the Bahama swallowtail have been sporadic. Some appear dubious and none provide evidence that the butterfly is established (Klots 1951; Kimball 1965). Existing data indicate that records of P. andraemon in Florida are the result of sporadic colonization attempts during which short-term breeding colonies may form, only to eventually die out (Miller 1975; Morrison 1981). In support of this hypothesis, Morrison (1981) pointed out that current taxonomic interpretation of P. andraemon does not recognize a distinct Florida subspecies. This would indicate that if establishment has ever taken place, it has not been of sufficient duration for genetic isolation to have occurred. It appears that Brown's 1973 paper provided the impetus to list the Bahama swallowtail as a threatened species. As stated by Covell (1977), no one except Brown and his students has seen this species in Biscayne National Park. Covell (1973) was collecting in the park at the same time that Brown (1973) reported seeing 100 Bahama swallowtail adults. It is difficult to believe that an experienced lepidopterist like Covell would collect the Schaus swallowtail but completely miss another large butterfly that occurred simultaneously in similar numbers and habitat. Covell (1977) continued to collect in the park area from 1973-1976 and never observed P. andraemon bonhotei. Similar negative results were obtained in 1977-1978 (James Tilmant, pers. comm.) and during our surveys. We examined a number of key lime trees each month for larvae and signs of feeding, but never observed P. andraemon larvae.

It should be noted that an inconsistency exists in Brown's identification (Brown, 1973, p. 139 and Brown 1974, p. 11). Recounting the same experience, Brown (1973) stated that he chased P. aristodemus ponceanus which eluded them over water, while in Brown (1974) he stated that it was P. andraemon bonhotei which eluded them. Both Brown (1973; 1974) and Covell (1977) use this incident to show that P. aristodemus ponceanus can fly between islands.

Based upon the survey results and on communications with other authorities, it appears that the Bahama swallowtail should be deleted from the Federal List of Endangered and Threatened Species. Sufficient evidence does not exist to support its presence as an established species in the United States, nor does P. andraemon bonhotei appear to be in danger of extirpation in its native Bahaman Islands. Additionally, it has become numerous in Jamaica where it was recently introduced (Tyler 1975). Under the 1978 amendments to the Endangered Species Act regarding

invertebrates, this subspecies should not be listed unless it can be shown to be in danger throughout a significant portion of its range. Until records of established breeding populations in this country can be verified, it must be assumed that the occurrence of this butterfly in the United States is sporadic.

Schaus swallowtail

In both 1979 and 1980, adults occurred in low numbers along the transects. The lower numbers observed in 1980 do not necessarily represent a decline but may be an artifact of the survey method. The emergence season in both years extended from late April to late June. These data correspond well to those of Covell and Rawson (1973) and Brown (1973). We found adults on Elliott, Adams, Totten, and Old Rhodes Key (Fig. 1), and it appears that the Schaus swallowtail is present in most hammocks on the keys in Biscayne National Park. The behavior of the adults in the hammocks centers around courtship, mating, and ovipositing. Some adults, possibly males, constantly flew about in light gaps in the canopy of the hammock. Here, in the shafts of sunlight, the butterfly would flutter aloft at a height of from 2-3 meters for minutes at a time. Often, one or more other adults would fly into this area to be chased away with the resident in pursuit. After a short period the same individual, identifiable by nicks in the wings, would return to the light gap. At other times, the resident butterfly would perform what appeared to be courtship flights with other butterflies that entered into the light gaps.

In 1981 the number of Schaus swallowtails recorded along the transects was lower than in 1979 and 1980. This decrease may be the result of high larval mortality in 1980 (Morrison 1981), or may be due to the severe spring dry season of 1981. The 1981 data indicate that spring droughts may affect the butterfly and its larval food plant by delaying emergence and leaf flush. On 13 May 1981, most torchwood trees were just beginning to produce new leaves and many trees showed no leaf flush at all. In past years most torchwood trees were fully flushed with new growth by late April (Morrison 1981; pers. observ.). A coincident delay in emergence of Schaus swallowtail adults occurred in 1981. The first adults were recorded on 13 May 1981, despite earlier surveys in late April and early May. The last sighting of adults occurred in mid-August 1981. The emergence period of the Schaus swallowtail appears to have been delayed by several weeks in 1981, coinciding with the delayed flush of new leaves by torchwood. Sightings in July and August, 1981, several weeks later than the final sightings in 1979 and 1980, indicate that the entire emergence season was retarded in 1981. In addition, other lepidopteran species along the transects showed a similar delay in emergence in 1981 when compared with the previous two years (Daniel Peters, pers. comm.). It appears that the severe spring dry season may have been responsible for the retardance of emergence in 1981, but this relationship requires much more research.

Fresh herbivory on torchwood leaves was observed within one or two weeks after the emergence of adult Schaus swallowtails. The adults presumably mate and lay eggs soon after emerging. We rarely observed ovipositing behavior, but on 24 May 1979, we were able to watch a female oviposit on wild lime (Zanthoxylum) leaves. We found no larvae in 1979 and few in 1980. It appears that few larvae are either produced or survive, and those which do survive through several instars often disappear before pupating (Morrison 1981). Much of the life cycle is spent in the pupal stage, in which it can remain in diapause for up to two years (Grimshawe 1940). It is possible that predation on the immature stages of the butterfly may be a major cause of mortality.

Covell (1977) discussed the possibility of a second emergence of Schaus swallowtail adults in late summer. We found no evidence for this in the two years of the survey, never observing adults after late June. The latest sighting in 1981 occurred in August and none were seen on subsequent surveys (Daniel Peters, pers. comm.). Food for early instar larvae produced by a second emergence would probably be scarce because they feed on the new leaves that are produced primarily in spring (Morrison 1981). This source would be much less available later in the year. It seems more likely that the late season records of adults represent sporadic emergences, possibly resulting from asynchronous termination of diapause.

The Schaus swallowtail has adapted to life within the shady tropical hammocks. Its normal population size appears to be low at all stages, although the numbers may follow a cyclical pattern. Though the population size has been small for the past eight years, large numbers of adults were present throughout the range in 1972 (Brown 1973; Covell and Rawson 1973). The factors leading to these changes in abundance and the periodicity of these cycles are not known.

When the population size of a species is low, any deleterious factor could send the species towards extinction. This is especially pertinent to the Schaus swallowtail, which is now restricted to a small portion of its original range and which apparently has naturally low population levels. Covell (1976) discussed in detail the human and environmental factors that might affect the status of the Schaus swallowtail. We shall review several of these as to their possible effects on the population in Biscayne National Park.

Freezes could have severe consequences for a tropical insect, but do not seem to be as damaging on the keys as they are on the mainland. During the hard freeze of 1977, no adverse effects were observed on the keys in the park because of the moderating effect of the surrounding waters (James Tilmant, pers. comm.).

Drought is believed by Covell (1976) to have a deleterious effect on Schaus swallowtail populations. Droughts occur naturally in south Florida and even during the wet years such as the past three, there is a period in winter and early spring when rainfall is low. It appears that P. aristodemus ponceanus emergence is timed to coincide with the beginning of the wet season in spring, the time of leaf flush in torchwood. There is also evidence that the pupae can overwinter for two years during a severe drought (Covell 1976), a capability which may have been an important evolutionary factor for this species (Morrison 1981). Possible effects of the severe dry season of 1981 on the butterfly population are discussed above. Surveys in 1982 may provide insight into deleterious effects of the 1981 dry season on this species.

Hurricanes can severely affect vegetation and insect populations in south Florida (Grimshawe 1940; Craighead 1971). A direct pass of a hurricane over the park's keys could severely impact the remaining population of the Schaus swallowtail through wind, flooding, and destruction of the food plant for several seasons. Such an event could extirpate the species, since populations in the hammocks on keys outside of the park from which recolonization could occur, have been severely reduced.

Human effects such as collecting, destruction of habitat, and insecticide spraying are of minimal consequence in the park. Good habitat outside of the park,

especially on Key Largo, is constantly being degraded or lost by aerial mosquito spraying and by destruction of hammock for development. The amount of collecting outside of the park is unknown. Poaching inside of the park is kept to a minimum by the isolation of the keys and protection by Park Rangers.

Additional information is needed on the biology, ecology, and population dynamics of the Schaus swallowtail. A draft recovery plan has been presented by Morrison (1981) to the Florida Game and Freshwater Fish Commission. In this plan, he discussed future research needs, and we concur that the following aspects require prompt attention. The effect of predation on population size through juvenile mortality and a number of other important life-history questions could be answered in the laboratory through captive breeding and rearing. Captive rearing has been done successfully in the past, using rutaceous plants other than torchwood as larval food sources (Rutkowski 1971), and such a program could supply butterflies for introduction into suitable habitats on the Middle and Lower Keys. The Schaus swallowtail should be reintroduced into areas suitable for colonization to reduce the chance of a natural disaster eliminating this species in Florida. In addition, hammocks in the Upper Keys should be preserved and protected from development to provide healthy habitats for the Schaus swallowtail outside of Biscayne National Park. The wide-spectrum pesticide spraying on the Upper Keys probably affects the butterfly populations so that the usage of pesticides outside of areas of human habitation should be examined and deleterious effects upon non-target organisms documented. The butterflies in Biscayne National Park appear to be the nucleus of the Schaus swallowtail population at this time. Little evidence of breeding outside of the park was found in 1980 (Morrison 1981). The keys in the park represent the last undisturbed Florida habitat for this insect, so that adult numbers should continue to be monitored during May and June along the two established transects to detect any further decrease in population size.

In summary, the Schaus swallowtail is a rare butterfly native to hardwood hammocks of the Upper Florida Keys. The population exhibits wide fluctuations in abundance, with the last peak having occurred in 1972. Numbers in recent years have been low. The emergence season begins in late April, lasting until late June. Much of the life cycle is spent in pupal stage, in which it can survive over two winters. Mortality appears to be high in the immature stages. Adults are sparsely but widely distributed over most suitable habitat in Biscayne National Park. The small population size may be an adaptation to relatively stable conditions within the hammock environment of the keys.

Additional Lepidopterans

The butterfly fauna of the Florida Keys shows a great affinity to that of the Greater Antilles (Scott 1972). Many of the species found along the survey routes in Biscayne National Park also occur in the Antilles. Elliott Key had a greater species diversity than Old Rhodes Key, which can be explained by differences between the transects. The transect on Elliott Key ran through mature hammock but also included edge habitat on the Spite Highway and some coastal habitat at Petrel Point. Battus polydamas was always found in this coastal area; other species, such as Hemiargus thomasi and Precis lavinia, were most abundant around hammock edges. Old Rhodes Key was more uniform in habitat, mainly mature hammock. Fewer of the butterflies appear to be adapted to such shady environments and so species diversity and total number were lower here. Two apparently well-adapted hammock species, Papilio aristodemus ponceanus and Eunica tatila were more common on Old Rhodes Key.

Numbers and diversity on both keys were lowest on the first survey at the end of winter, but showed a continuous increase until July. In July, numbers and diversity on both islands fell, then increased again in August, and fell once more in September.

A number of species occurred more frequently in 1980 than in 1979. These included Papilio cresphontes, Phoebis agarithe, and Phyciodes frisia. Others were recorded for the first time in 1980, such as Precis lavinia, Urbanus proteus, and Polygonus lividus. A number of butterflies show a spring-summer emergence on the Keys. Papilio aristodemus ponceanus, Marpesia petreus, Battus polydamas, and Erebus odora occurred only from May to July. Two species, Eunica tatila and Dryas julia, occurred on every survey on Old Rhodes Key in 1980, as did Appias drusilla, Phoebis agarithe, Dryas julia and Hemiargus thomasi on Elliott Key.

The butterfly fauna of the Keys in Biscayne National Park is closely related to that of the Greater Antilles. Numbers and diversity of adult lepidopterans are lowest during the early spring and fall, increasing in summer. The diversity and number of species is related to the number and variety of habitats available on the keys and to the extent of adaptation by each species to the hammock environment.

RECOMMENDATIONS

1. Because evidence supporting the establishment of the Bahama swallowtail (Papilio andraemon bonhotei) in the United States is lacking, this species should be deleted from the Federal List of Endangered and Threatened Species.

2. If the present trend in population size decline and range contraction continues, the Schaus swallowtail should be elevated to the status of an endangered species on the federal list.

3. A captive breeding stock of the Schaus swallowtail should be established for purposes of biological and ecological research and as a source for reintroduction in suitable habitats.

4. To preserve the Schaus swallowtail as a wild breeding population in the United States, the following steps are recommended:

   a) Identify all existing colonies by surveying during the adult emergence period.

   b) Monitor these colonies by surveying them during the adult emergence period.

   c) Protect the existing habitat from any further degradation.

   d) Identify the habitat characteristics necessary for the survival of this species.

   e) Identify all suitable hardwood hammock habitats in the Florida Keys; establish new colonies in those hammocks by captive-breeding of individuals for reintroduction.

5. To provide basic information on the life history and survival of the Schaus swallowtail, the following research is recommended:

   a) Investigate the effects of environmental parameters on larval and pupal stages, especially as concerns the length of pupal diapause.

   b) Identify all predators and measure survival at all life stages.

   c) Determine the effect of pesticides used in the keys on all life stages, and discontinue usage of deleterious chemicals in hammocks suitable for Schaus swallowtails.

   d) Identify the causes of extirpation of this species from hammocks in the keys which still provide apparently suitable habitat.

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Table 1. Lepidopterans encountered along transects on Elliott Key (E) and Old Rhodes Key (O) from March through September 1979.

Species	19 Mar.	12 April	24 May	19 June	25 July	30 Aug.	27 Sept.
Papilio aristodemus ponceanus Schaus swallowtail			E,O				
Papilio cresphontes Giant swallowtail		E	E	E			
Battus polydamas Polydamas swallowtail			E	E			
Appias drusilla Florida white	O	O	E,O	E,O	E,O	E,O	E,O
Phoebis agarithe Sulphur		E				E,O	E
Eunica tatila tatilista Florida purplewing	O	O	O	E,O	O	O	E,O
Hemiargus thomasi bethunebakeri Miami blue	O	E	E	E	E		E
Phyciodes frisia Cuban crescent	O						
Danaus gilippus Queen	O			E			
Marpesia petreus Ruddy daggerwing			E		E		
Heliconius charitonius Zebra	O	E	E,O	E			E

Table 1 continued

Species	19 Mar.	12 April	24 May	19 June	25 July	30 Aug.	27 Sept.
Dryas julia Julia	O	E,O	E,O	E,O	E,O	E,O	E,O
Agraulis vanillae Gulf fritillary					E		E,O
Composia fidelissima Day flying pericopid					O	O	E
Erebus odora Black witch				E			

Table 2. Number of adult lepidopterans observed along a one km survey route on Elliott Key in 1980.

Species	31 Mar.	22 April	5 May	20 May	23 June	17 July	25 Aug.	29 Sept.
Papilio aristodemus ponceanus Schaus swallowtail			2	2	2			
Papilio cresphontes Giant swallowtail	5	5	1	9		2	1	
Battus polydamas Polydamas swallowtail			3	3				
Appias drusilla Florida white	2	6	4	26	14	5	9	2
Phoebis agarithe Sulphur	2	3	1	3	18	8	6	4
Eunica tatila Florida purplewing					2		1	
Hemiargus thomasi Miami blue	2	1	4	7	4	5	4	1
Phyciodes frisia Cuban crescent				3	4		1	1
Danaus gilippus Queen					2	2		
Marpesia petreus Ruddy daggerwing			2	1				
Dryas julia Julia	10	12	9	20	3	5	27	15

Table 2 continued

Species	31 Mar.	22 April	5 May	20 May	23 June	17 July	25 Aug.	29 Sept.
Heliconius charitonius Zebra		3	4	2	2	5	12	10
Agraulis vanillae Gulf fritillary					2		3	2
Precis lavinia Buckeye	1			2		2		
Urbanus proteus Long-tailed skipper							2	
Polygonus lividus Hammock skipper								
Unidentified skippers (2 species)	2	1					1	1
Composia fidelissima Day-flying pericopid								1
Total Number	24	31	28	79	54	34	67	39
Total Species	7	7	8	11	11	8	11	10

Table 3. Number of adult lepidopterans observed along a one km survey route on Old Rhodes Key in 1980.

Species	31 Mar.	22 April	5 May	20 May	23 June	17 July	25 Aug.	29 Sept.
Papilio aristodemus ponceanus Schaus swallowtail			2	4				
Papilio cresphontes Giant swallowtail		3	1	2	1			1
Appias drusilla Florida white		11	21	29	16	10	15	3
Phoebis agarithe Sulphur			1	4	4	1	1	1
Eunica tatila Florida purplewing	2	1	1	2	4	2	9	7
Dryas julia Julia	1	11	12	12	1	3	4	5
Heliconius charitonius Zebra						1	2	
Polygonus lividus Hammock skipper				1				
Composia fidelissima Day-flying pericopid			2		1	1	2	
Erebus odora Black witch					1	1	1	
Total Number	3	26	41	54	28	19	34	17
Number of Species	2	4	7	7	7	7	7	5

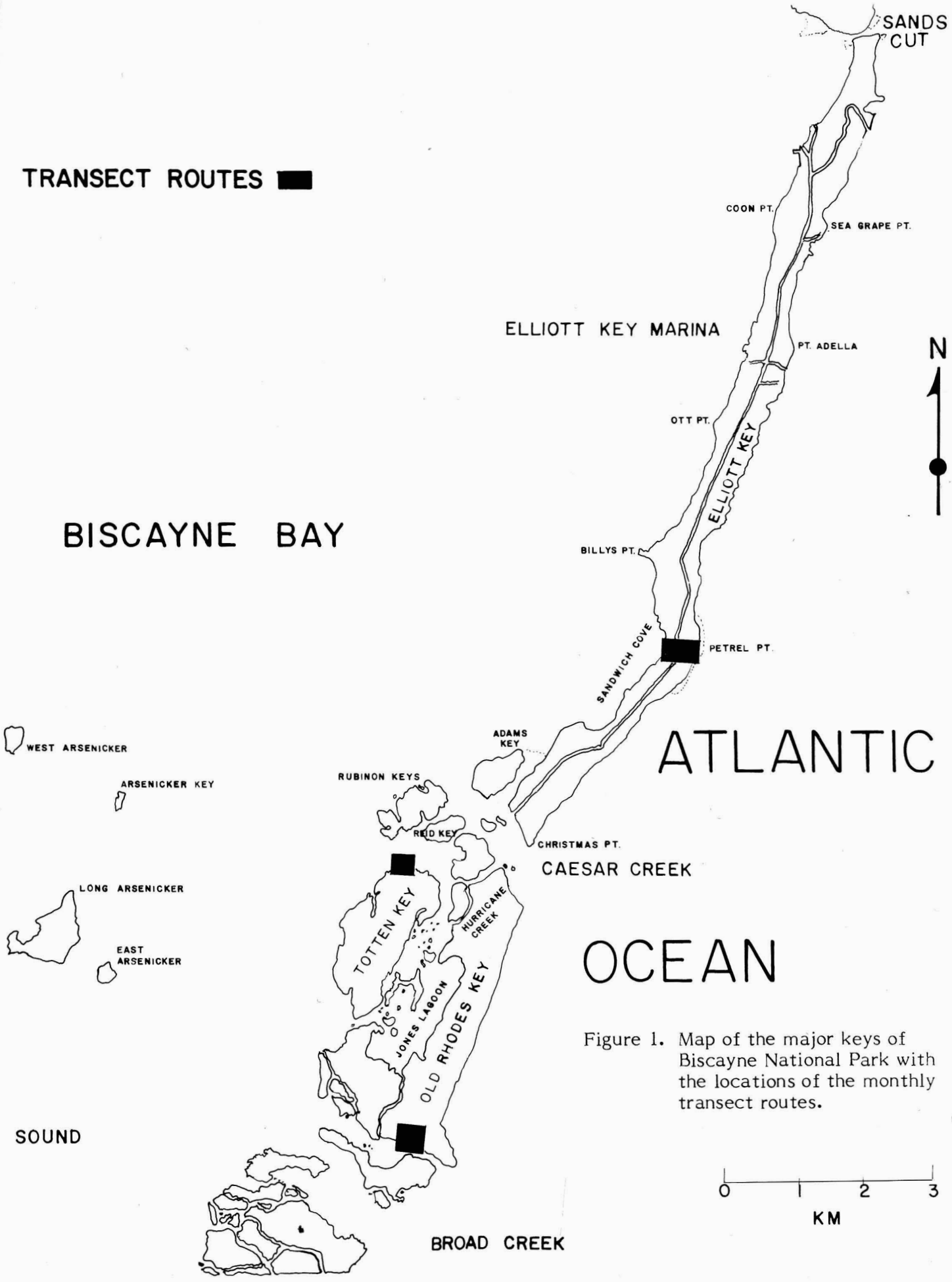

Figure 1. Map of the major keys of Biscayne National Park with the locations of the monthly transect routes.