Herpetologica, 44(2), 1988, 197–202

AGGRESSIVE BASKING BEHAVIOR IN EASTERN PAINTED TURTLES (*CHRYSEMYS PICTA PICTA*)

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ABSTRACT: Aggressive basking behavior was a frequent and conspicuous part of the daily activities of free-living *Chrysemys picta picta* in northern Virginia. Inter- and intra-specific interactions included open mouth gestures, biting, and two previously undescribed behaviors: lateral and vertical displacement. Aggression was most frequent from 0900–1000 h, at water temperatures between 30–32 C. Basking turtles avoided potentially aggressive encounters by averting faces while basking and moving away from approaching turtles. Directionality of behavioral interactions was strongly influenced by relative body size. Aggressive behavior was positively correlated with the number of turtles basking, the frequency of emergences, and water temperature.

Key words: *Chrysemys picta*; Basking; Behavior, agonistic; Bite; Open mouth gesture; Behavior, displacement

THE basking habit of turtles has been studied extensively (Auth, 1975; Boyer, 1965; Crawford et al., 1983; Ernst, 1972; Moll and Legler, 1971; Obbard and Brooks, 1979; Schwarzkopf and Brooks, 1985; Spotila et al., 1984; Waters, 1974), but relatively little is known of behavioral interactions among basking turtles. Bury and Wolfheim (1973) reported that aggressive interactions were frequent among basking *Clemmys marmorata*, and Bury et al. (1979) observed similar behavior in free-

living *Chrysemys picta bellii*. They suggested that the function of these aggressive interactions, which consisted of biting, pushing, and open mouth gestures, was to gain access to preferred basking sites and to maintain spacing between turtles. Although this behavior has been noted for an eastern population of *C. picta* (Litwin, 1975*a*,*b*), its frequency has not been measured despite numerous ecological investigations of the species (Cagle, 1954; Ernst, 1971; Gibbons, 1968; Sexton, 1959). In this paper, I report on the occurrence and frequency of aggressive basking behavior (ABB) in free-living eastern painted turtles (*Chrysemys picta picta*).

Materials and Methods

I spent 98.5 h observing turtles at Mason Neck National Wildlife Refuge, Fairfax County, Virginia. The study site was located along a stream flowing through a tidal marsh adjacent to the Potomac River. Numerous snags, stumps, and trees felled by beavers (*Castor canadensis*) were present providing an abundance of potential basking sites. The period of study extended from June–September 1982 and from May–September 1983. Observations were conducted at irregular intervals between 0730–1600 h with most between 0800–1300 h when basking activity was greatest.

A 22 × 600 cm log was secured in a deep channel where turtles were frequently seen. My observation point was concealed behind vegetation 20 m away. Turtles were observed basking on this surface within several hours of placement. Behavior was monitored with a 60× spotting telescope and was recorded on data sheets in 15 min intervals noting species, relative size, and sex when possible. The number of turtles basking, submerging, and emerging was recorded every 15 min, and the mean per hour was calculated from four consecutive intervals. Air (1 m above ground) and surface water (shoreline) temperatures were measured hourly with a hand-held thermometer.

The following operational definitions (Bury et al., 1979) were adopted a priori. *Gape*.—Any definite opening of the mouth not obviously directed at another turtle. *Open mouth gesture*.—Opening the mouth and directing gesture toward another turtle. *Bite*.—Clamping the mouth onto any part of another turtle's body. *Push*.—One turtle attempts to physically displace another turtle, either with the shell or an appendage. *Avoid*.—Any movement (e.g., withdrawal of the head) or evasive locomotion which tends to maintain or increase the distance between two turtles.

Statistical techniques were performed using MINITAB (Ryan et al., 1982). Regression and correlation analyses were executed on untransformed parametric data to facilitate direct comparison with results reported by Bury and Wolfheim (1973) and Bury et al. (1979). Critical values of Pearson product-moment correlation coefficients (r) were obtained from Rohlf and Sokal (1981). Tests were considered significant at $P < 0.05$.

Results

Intraspecific Aggressive Basking Behavior

A total of 206 aggressive interactions were observed among basking *C. picta* including open mouth gestures (OMG), biting, and a previously undescribed behavior which I call lateral displacement behavior (LDB) (Table 1). Interactions usually involved only two individuals, but chain reactions were occasionally triggered among several turtles as described below.

The most frequent form of aggressive basking behavior was the OMG. These generally occurred when turtles were face-to-face, but some were directed at the limbs and shells of moving turtles. Turtles receiving an OMG turned or moved away from the initiator in 25% (n = 30) of observed interactions involving this behavior. Retaliation was seen only twice and involved a return of OMG's. No obvious response was detected in remaining interactions. Biting was relatively infrequent, accounting for 14% (n = 29) of all aggressive acts. Attacks were directed at the nearest portion of a turtle's shell or body, but aggressors occasionally missed and closed their jaws in mid-air. All cases of biting were followed by avoidance (n =

TABLE 1.—Comparison of basking behavior in different species of turtles. Percentages of aggressive interactions are in parentheses. Hours indicated are total hours, not man-hours. OMG = open mouth gesture, LDB = lateral displacement behavior, VDB = vertical displacement behavior.

Behavior	Species			
	Chrysemys p. picta (this study)	*Chrysemys p. bellii* (Bury et al., 1979)	*Clemmys marmorata* (Bury and Wolfheim, 1973)	*Pseudemys rubriventris* (this study)
Basking	501	464	—	9
Emerging	1055	1052	—	13
Submerging	1019	—	—	12
Gapes	107	43	—	6
OMG	119 (58)	284 (47)	111 (76)	—
Biting	29 (14)	9 (2)	11 (8)	—
Pushes	0	310 (51)	23 (16)	—
LDB	55 (27)	—	—	—
VDB	—	—	—	3
Total aggressive acts	206	603	145	3
Hours	98.5	27	37	98.5

26) or retaliation (n = 3). The third form of ABB was seen only when turtles were stacked on top of each other. Typically this involved one turtle resting the anterior portion of its plastron on the posterior portion of another's carapace (n = 28), but stacks of three were observed on four occasions. This frequently elicited lateral displacement behavior from the bottom turtle which would elevate the rear portion of its shell and rock laterally in an apparent effort to dislodge the upper turtle(s). Episodes lasted 3–5 s and were often repeated ($\bar{x}$ = 1.7 times/observed stacking event). Upper turtles were physically displaced or moved of their own volition in 80% (n = 17) of observed stacking events with LDB. No response was detected in the others. LDB was more frequent when relatively larger turtles were stacked on smaller turtles than vice versa (χ^2 = 8.0; 1 df; P < 0.005).

Aggressive interactions were observed throughout the day but were most frequent between 0900–1000 h, an hour earlier than peak basking activity (Table 2). OMG's were proportionally most frequent between 0900–1000 h when the rate of emergence was highest. The proportion of biting incidents was greatest between 1000–1100 h, and LDB peaked between 1100–1200 h when large numbers of turtles were basking and stacking was frequent.

Reactions to ABB varied as did the ultimate outcome of interactions (Fig. 1). In one case, three turtles (two males, one female) were partially stacked (each in contact with the substrate and another turtle). The end female initiated LDB causing the middle male to turn toward the posterior male who then directed a series of OMG's at it. The middle male responded by biting the shell of the posterior male and then rotating 90°. In another case, a large male was observed resting his chin on the posterior carapace of a smaller male. The smaller turtle initiated LDB, but no response was detected and the two continued to bask.

ABB was seen among and between males, females, and juveniles. Insufficient data were obtained to test for differences in the directionality of behavior between

TABLE 2.—Frequency of aggressive behaviors vs. time of day as observed among basking *Chrysemys picta* and conspecifics. Refer to Table 1 for abbreviations.

Time (h)	Behavior		
	LDB	Biting	OMG
0700–0800	—	—	—
0800–0900	2	1	2
0900–1000	17	8	48
1000–1100	17	10	28
1100–1200	19	6	33
1200–1300	—	3	6
1300–1400	—	—	2
1400–1500	—	1	—
1500–1600	—	—	—
1600–1700	—	—	—

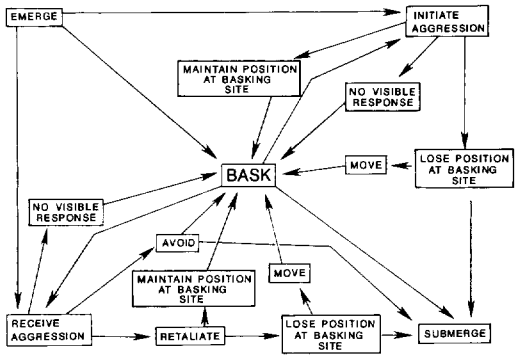

FIG. 1.—Flowchart of possible actions and reactions exhibited by basking *Chrysemys p. picta*.

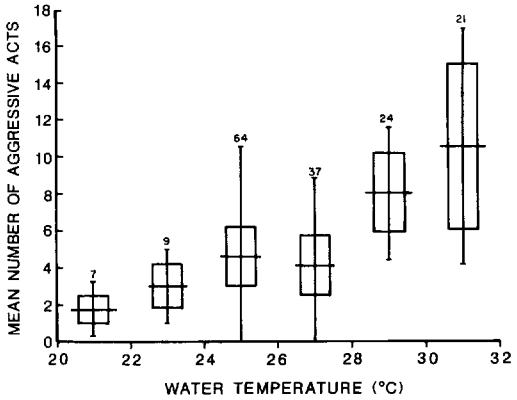

FIG. 2.—Relationship between the mean ± 1 SD (bar) and 1 SE (box) non-zero number of aggressive acts and water temperature for the degree intervals indicated. Numerals above bars represent the total number of aggressive acts observed in each temperature interval.

the sexes, but larger turtles directed more OMG's toward smaller turtles than vice versa ($\chi^2 = 10.8$; 1 df; $P < 0.005$). Some basking *C. picta* appeared to avoid situations that might provoke aggressive interactions by moving away from approaching turtles. In addition, emerging turtles often "selected" unoccupied stations at the basking site when it was crowded, because those that emerged amidst large numbers of conspecifics usually stimulated ABB. Face-to-face encounters were minimized because groups of *C. picta* generally aligned themselves head-to-tail while basking.

The rate of ABB was moderately influenced by crowding at the basking site. Weak but significant correlations existed between the total number of aggressive acts per hour and the mean number of turtles basking per hour ($r = 0.51$; 95 df; $P < 0.01$), and emerging per hour ($r = 0.39$; 93 df; $P < 0.01$). Aggression was rarely observed when an inter-turtle spacing of approximately one carapace length or more was maintained. Regression of the non-zero number of aggressive acts per hour on water temperature was significant ($F = 5.24$; 1,33 df; $P < 0.03$; $r = 0.37$: Fig. 2).

Interspecific Aggressive Basking Behavior

I observed two instances of ABB between *C. picta* and *Pseudemys rubriventris*. One interaction involved another unreported behavior for basking turtles which I call vertical displacement behavior (VDB) (Table 1), that was only seen when turtles were stacked. Under these circumstances, the lower turtle would alternately raise and lower the rear portion of the carapace in an attempt to displace the upper turtle. On one occasion, a female *C. picta* crawled on top of a smaller *P. rubriventris*. This initiated a series of VDB's by the lower animal. After displacing the upper turtle, the *P. rubriventris* submerged only to reemerge several seconds later at a new position on the log. Another example of ABB was observed between these two species when a juvenile *P. rubriventris* crawled onto the posterior carapace of an equal size *C. picta*. The lower turtle initiated LDB, but no response was detected and the two continued to bask without further incident.

DISCUSSION

The results of this study indicate that agonistic behavior is frequent and conspicuous among basking *Chrysemys p. picta*, a turtle that was formerly thought to take little notice of other basking turtles (Ernst, 1971), except under crowded conditions in captivity (Ernst, 1964). Behavioral interactions were similar to those observed by Bury and Wolfheim (1973) for *Clemmys marmorata* and Bury et al. (1979) for *Chrysemys p. bellii*. Notable exceptions included pushing, which I never observed, and a new behavior reported

TABLE 3.—Comparison of basking activity and rates of aggression. See Table 1 for references.

Rate of behavior	Species		
	Chrysemys p. picta	*Chrysemys p. bellii*	*Clemmys marmorata*
Mean number of turtles basking/hour	5.1	6.5*	17.2
Mean number of turtles emerging/hour	10.7	—	39.0
Aggressive interactions/hour	2.1	3.9	22.3
Aggressive interactions/emergence	0.2	—	0.6
Aggressive interactions/submergence	0.2	—	—

* During 5 h peak from 0800–1259 h.

in this paper as lateral displacement behavior. Pushing behavior has been reported among basking *Graptemys geographica* (Pluto and Bellis, 1986) and several species of *Pseudemys/Trachemys* (Auth, 1975; Pritchard and Greenhood, 1968).

As in other studies (Bury and Wolfheim, 1973; Bury et al., 1979; Pluto and Bellis, 1986), larger turtles effectively displaced smaller individuals more often than the converse situation. However, smaller *Chrysemys p. picta* were more likely to initiate LDB toward a larger turtle than vice versa. The occurrence and directionality of this specific behavior is difficult to explain. However, it is possible that solar heat absorption by lower turtles in a stack is adversely affected by the presence of relatively large upper turtles.

There are considerable differences in the rates of aggressive behavior reported in this and previous studies (Table 3). This variance may be due to differences in the number of basking sites available, quality of basking sites, population densities, and the species investigated. Manipulation of these factors will be necessary to determine their possible importance.

Interspecific ABB appears to be infrequent between *C. picta* and *P. rubriventris*. Interactions were minimized because of low numbers of *P. rubriventris* relative to *C. picta* and the fact that *P. rubriventris* generally selected basking sites that were farther from shore and near deeper water than those utilized by *C. picta*.

It is interesting that ABB should exist at all when basking sites appeared to be plentiful at my study site. However, previous researchers have observed that emydid turtles generally select basking sites that are far from shore, near deep water, and provide a good view of the area (Auth, 1975; Boyer, 1965; Bury et al., 1979; Moll and Legler 1971). The basking log that I observed fit all of these criteria. Thus, my results seem to confirm the hypothesis of Bury et al. (1979) that the function of ABB is to obtain and maintain a space on a preferred basking site.

The basking habits of many species of turtles are well documented, yet few cases of ABB have been reported. I suggest that the phenomenon may be more widespread than previously assumed and that more evidence of its existence will be discovered as ethological rigor is stressed in studies of basking ecology.

Acknowledgments.—I thank C. H. Ernst for many useful suggestions during the study. J. W. Gibbons, J. D. Congdon, and three anonymous reviewers offered numerous useful criticisms on earlier versions of the manuscript. Field assistance was provided by S. W. Gotte and R. G. Hostetter. J. A. Hinton typed the manuscript. This paper constitutes a portion of a thesis submitted in partial fulfillment of the requirements for a Master of Science degree at George Mason University. Funding was provided by a Sigma Xi Grant-in-Aid of Research. Manuscript preparation was supported by DOE grant DE-ACO9-76SROO-819 to the University of Georgia.

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Accepted: 6 May 1987
Associate Editor: Raymond Semlitsch