

THERMAL ECOLOGY OF HAWAIIAN BASKING
GREEN SEA TURTLE

NATIONAL GEOGRAPHIC PROPOSAL

by

G. Causey Whittow
George H. Balazs

February 1977

(78)

Name of Applicant: *Whittow George Causey
Last First Middle
Kewalo Marine Laboratory, Pacific Biomedical Research Center, University of Hawaii,
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Date: Feb. 16, 1977

Sept 22 - 28, 77

Return to:

Committee for Research and Exploration
National Geographic Society
17th and M Streets, N.W.
Washington, D. C. 20036

Applications must be typewritten within the margins on one side of page only with heavily inked ribbon. The application must be limited to these seven pages. If additional materials are essential to a full understanding of the project, they may be attached and will be kept in the office of the Committee Secretary where they may be consulted by Committee members.

1. Project title (ten words or less): Thermal Ecology of Hawaiian Basking Green Sea Turtles

a. Under what major field of science do you classify this project? Physiological ecology, zoology

b. Funds requested from National Geographic Society (U.S.A. currency) \$ 4,010

c. Expected duration of the project. (Specify dates of field and laboratory study). It is expected that field and laboratory measurements and observations will proceed over a period of two years (June 1977 - June 1979).

d. Location of field work French Frigate Shoals, Northwestern Hawaiian Islands

e. Abstract of Proposed Research.

The green sea turtle (Chelonia mydas) population of the Northwestern Hawaiian Islands is quite unique in one respect: the turtles voluntarily and habitually haul out on the hot sandy beaches of the undisturbed islands, and bask in the sun, for considerable periods of time. Although basking is common in some species of fresh-water turtles, and although several hypotheses have been advanced to explain this behavior, it is not fully understood why turtles bask. We believe that if we find out what happens to the Hawaiian green sea turtles, when they bask, we shall be in a much better position to decide why they do so. We propose, therefore, to conduct a complete documentation of the behavior of basking green sea turtles, to make simple physiological measurements on some of them, and to measure, accurately, the thermal energy transfer between the turtle and its environment. An important part of this work will be to determine how much of the high levels of solar radiation, to which the turtles are exposed, is absorbed by the carapace. This information, we trust, will not only throw considerable light on the phenomenon of basking, but it will also provide valuable data on the bioenergetics of green sea turtles, data which we hope will be of value in conservation programs for the species.

*and George Harvey Balazs, Hawaii Institute of Marine Biology, University of Hawaii, Coconut Island, P.O. Box 1346, Kaneohe, Hawaii 96744.

Name of Applicant: G. Causey Whittow and George H. Balazs

2. Biographical information and qualifications of the applicant:
(In addition, please attach curriculum vitae for committee files)

G. Causey Whittow

- a. Present position (institution and rank): Professor of Physiology, School of Medicine and Pacific Biomedical Research Center, University of Hawaii
- b. Place and date of birth:
Milford Haven, Wales, Great Britain, 28 February 1930.
- c. Education and degrees with institutions and dates:
B.Sc. (Honors) in Physiology, University of London, England, 1952.
M. I. Biol. England, 1953
Ph.D. in Physiology, University of Malaya, 1957
F.L.S. (England), 1976
- d. Special qualifications of applicant for proposed research (experience, languages, etc.):
G. Causey Whittow has had considerable experience in the investigation of problems in thermal biology, both under field conditions and in the laboratory, and on a wide variety of species. Whittow is quite familiar with French Frigate Shoals, the study area, having worked there on the Hawaiian Monk Seal for the past year. (See attached letter dated November 1, 1976.)

If others are to participate in this project, please give the same biographical information and qualifications for each person in the space below:

George H. Balazs

- a. Jr. Marine Biologist, Hawaii Institute of Marine Biology, University of Hawaii
- b. Detroit, Michigan, 26 February 1943
- c. B.S. in Animal Sciences, University of Hawaii, 1967
M.S. in Animal Sciences, University of Hawaii, 1969
- d. Since 1973 George H. Balazs conducted intensive original investigations of the reproductive biology and population ecology of green sea turtles at French Frigate Shoals. He is presently the Principal Investigator of a three-year management study, funded by the State of Hawaii, of green sea turtles throughout the Hawaiian Archipelago (initiation date - July 1976).

Name of Applicant: G. Causey Whittow and George H. Balazs

3. Books and papers published by the applicant and others who will participate in the proposed research. (A statement such as the following is satisfactory: I have published 3 books and 70 articles (give number), but only the following are on topics directly related to the proposed research.) (Please attach complete bibliography for committee files.)

G. Causey Whittow

- Whittow, G. C., Matsuura, D. T. and Lin, Y. C. (1972). Temperature regulation in the California Sea Lion (Zalophus californianus). *Physiol. Zool.* 45, 68-77.
- Whittow, G. C. (1973). Evolution of thermoregulation. In *Comparative Physiology of Thermoregulation*, Vol. III., Ed. G. Causey Whittow. Academic Press, New York.
- Matsuura, D. T. and Whittow, G. C. (1974). Oxygen uptake of the California Sea Lion and Harbor Seal during exposure to heat. *Am. J. Physiol.* 225, 711-715.
- Ohata, C. A. and Whittow, G. C. (1974). Conductive heat loss to sand in California Sea Lions and a Harbor Seal. *Comp. Biochem. Physiol.* 47A, 23-26.
- Hochachka, P. W., Owen, T. G., Allen, J. F., and Whittow, G. C. (1975). Multiple end products of anaerobiosis in diving vertebrates. *Comp. Biochem. Physiol.* 50B, 17-22 (includes green sea turtles).
- Matsuura, D. T. and Whittow, G. C. (1975). Thermal insulation of the California Sea Lion during exposure to heat. *Comp. Biochem. Physiol.* 51A, 757-758.
- Whittow, G. C., Szekerczes, J., Kridler, E., and Olsen, D. L. (1975). Skin structure of the Hawaiian Monk Seal (Monachus schauinslandi). *Pacific Science* 29, 153-157.
- Hampton, I. F. G. and Whittow, G. C. (1976). Body temperature and heat exchange in the Hawaiian Spinner Dolphin, Stenella longirostris. *Comp. Biochem. Physiol.* 55A, 195-197.

George H. Balazs

I have published 1 booklet and 12 articles, but only the following are on topics directly related to the proposed research.

- Balazs, G. H. (1973). Status of marine turtles in the Hawaiian Islands. *Elepaio, J. Hawaii Audubon Soc.* 33(12):1-5.
- Balazs, G. H. and Ross, E. (1974). Observations on the basking habit in the captive juvenile Pacific green turtle. *Copeia*, 2:542-544.
- Balazs, G. H. and Ross, E. (1974). Observations on the preemergence behavior of the green turtle. *Copeia*, 4:986-988.
- Balazs, G. H. (1976). Green turtle migrations in the Hawaiian Archipelago. *Biological Conservation*, 9:125-140.

4. Method of publication of scientific results of proposed study: Papers in *Copeia*, *Ecology* or *Thermal Biology*.

Name of Applicant: G. Causey Whittow and George H. Balazs

5. Budget

a. Total budget for the project: \$ 4,010

If funds have been requested from other sources, attach budgets. Contributions from investigator's home institution should be listed under Item 6.

b. Amount requested from National Geographic in U.S.A. currency: \$ 4,010

c. Budget for funds requested from National Geographic Society. Please specify: e.g., equipment, assistants, field work, travel, services, supplies, etc. The Committee requires that budget items be given with precision and in detail. Two columns may be used. Include on pages 6-7 justification for any items that are not clear. (IMPORTANT: No charge for overhead is allowed. If any capital items are purchased with Society funds, the items or their salvage value are to be returned to the Society upon completion of the project.)

Equipment

Pyranometer and meter for measuring short-wave solar radiation	\$975
Pocket transit to partition solar sky and terrestrial radiation	85
Thermistor probes for temperature measurements	150
Heat flow discs	300

Supplies

Film and processing	\$120
Packing materials & protective cases for equipment	170
Batteries, thermometers, optical paints	185
Replacement probe for anemometer	80
Repairs and adjustment to radiometer	100
Xerox costs	100

<u>Fuel Costs for boat</u> , \$10/day; 30 days	\$300
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Per diem

Expenses at French Frigate Shoals (Two people, \$25/person/week; 6 weeks)	\$300
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<u>Local travel</u> - automobile, 300 miles at 15¢/mile	\$ 45
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Publication Expenses

Page charges, reprints, preparation of illustrations	\$500
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Fabrication

Artificial basking ramp for turtles at Kewalo Marine Laboratory	\$300
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<u>Food Costs for Eight Captive Turtles</u>	\$300
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d. Person or institution (with address) to whom payment should be made: \$4,010

G. Causey Whittow and George H. Balazs, University of Hawaii, 41 Ahui Street, Honolulu, Hawaii 96813.

e. Schedule of payments desired:

75%, June 1977

25%, January 1978

Before the application is considered, the Society must be informed that all necessary permits for field work (collecting or excavating) and laboratory, museum, or library study have been obtained; and that if foreign travel is involved, the participants have valid passports and required visas. Permits for work in the Hawaiian Islands

National Wildlife Refuge are issued by Palmer C. Sekora, Refuge Manager, U.S. Fish and Wildlife Service, Hawaii. Our research on the green sea turtles is covered by Special Use Permit (SUP) HWN-5-76, and HWN-12-76.

Name of Applicant: G. Causey Whittow and George H. Balazs

6. Amount and nature of institutional or other contributions toward this work. (If you are receiving no aid on this project from a university or other organization, or other individual, please explain):

No direct financial support from any other organization. The University of Hawaii pays Whittow's salary and provides space and office supplies. Balazs' salary is paid through the University of Hawaii by a State of Hawaii legislative grant to conduct green sea turtle management studies. The U.S. Coast Guard provides air transport to French Frigate Shoals. The U.S. Fish and Wildlife Service permits us to use their quarters on Tern Island and their boat. The following items of equipment, purchased with previous grants, will be used in this study: YSI

Telethermometer, Barnes Radiometer, Black-globe thermometer, Turner Heat-flow meter, Alnor Velometer, Hygrometer. See also attached letter to Dr. Snider.

7. Previous grants (date, source and amount) received for this work, grants now available, or applications to other organizations which are now pending. State whether they are alternative to your request to the Society. If another request for a grant is made after this proposal is sent to the Society, please notify the Society at once.

None. Please refer to our letter to Dr. Snider, dated November 1, 1976, a copy of which is attached.

8. Previous grants from the National Geographic Society for any project. (List project title, date and amount.)

Physiological Ecology of the Hawaiian Monk Seal (Monachus schauinslandi).
July 1, 1976 - June 30, 1977. \$1,650.00

9. Names and addresses of at least three individuals competent to pass judgment upon your qualifications and/or your project. (Note: The Society will get in touch with your referees. In addition, the Committee has its own sources of information, and the referees you suggest may or may not be consulted.)

Whittow: Dr. Charles V. Paganelli
Department of Physiology
School of Medicine and Dentistry
State University of New York
Buffalo, NY 14226

Dr. Robert E. Kane, Director
Kewalo Marine Lab
41 Ahui Street
Honolulu, HI 96813

Balazs: Dr. Archie Carr
Department of Zoology
University of Florida
Gainesville, FL 32611

Dr. John E. Bardach, Director
Hawaii Institute of Marine Biology
University of Hawaii, P.O. Box 1346
Kaneohe, HI 96744

10. If the grant requested here is approved, the applicant pledges himself to present a preliminary report on the project to the National Geographic Society on December 31, 1977, 1978 (give date) and a final formal report on December 31, 1979 (give date). The final report is to include an abstract suitable for publication in the Society's Research Reports and a one-page summary.

Signature: G. Causey Whittow

Typed name: G. Causey Whittow

Signature: George H. Balazs

Typed name: George H. Balazs

Name of Applicant: G. Causey Whittow and George H. Balazs

Describe the proposed research in some detail on pages six and seven. Relate what you propose to do to previous and current work on the subject by yourself or others. (Cite references to published work.) Include a description of any special techniques that will be used.

Introduction

Although basking, on land, is a common behavior in many species of fresh-water turtles (Boyer, 1965), the only sea turtles presently believed to emerge voluntarily from the ocean to bask are green sea turtles (*Chelonia mydas*) in the Northwestern Hawaiian Islands (Balazs and Ross, 1974). It is not known why turtles bask; in the case of the fresh-water species that do so, it has been suggested that an increase in body temperature is the primary benefit to be derived from basking, with additional advantages accruing from drying of the skin and shell (Cagle, 1950; Boyer, 1965). In the special instance of the green sea turtles, basking occurs under extremely hot conditions and for prolonged periods of time (Balazs and Whittow, unpublished observations). During this time, the turtles are exposed to high levels of solar radiation. It is not known how much of this radiation is absorbed or reflected.

Objectives

The major objectives of the proposed study are (a) to compile a detailed description of the behavior of the turtles during basking, particularly with regard to the prevailing meteorological conditions, (b) to measure accurately the heat exchange between the turtles and their environment, with special reference to the absorption of incident solar radiation. These data will reveal what happens to the turtles, thermally, when they bask. With this information it should be possible to decide whether the turtles bask in order to gain heat. If significant heat storage does not occur, clearly basking must subservise some other purpose.

Location of study

Most of the observations will be made on the natural population of turtles at French Frigate Shoals in the Hawaiian Islands National Wildlife Refuge. Additional studies will be made on captive turtles at the University's Kewalo Marine Laboratory and Hawaii Institute of Marine Biology.

Schedule

Observations will be made at regular intervals throughout the year so that basking behavior may be related to seasonal climatic variations.

Procedures

Behavior. Single basking turtles will be observed continually, with the aid of binoculars, to document their size, sex, orientation with regard to the sun, position on the beach, and dryness of the substrate. Groups of turtles will also be watched, and the incidence of basking, in relation to the time of day, season, and meteorological conditions will be recorded.

Physiological measurements. The respiratory frequencies of basking turtles will be counted, by observation, as an index of breath-holding and a possible reduction of metabolism and evaporative heat loss. Rectal temperatures will be measured after

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various durations of basking in order to determine the degree of heat storage by the animal. The surface temperature of the turtle will be measured remotely with a radiometer, and, in captive turtles, heat transfer from the plastron to the substrate will be determined with heat flow discs. The reflectivity of the carapace to solar radiation both in living animals and on dead shells will be determined with a pyranometer, using techniques described by Hutchinson *et al.* (1975). On at least one captive animal, the temperature gradient across the carapace will be determined by measuring the surface temperature with a radiometer, and the temperature beneath the carapace with a fine thermistor carefully inserted through a small hole drilled through the shell. A similar measurement will be made of the temperature beneath the plastron. In conjunction with data for the thermal conductivity of the carapace and plastron, determined on small segments of shell in the laboratory, this information will permit the estimation of heat transfer through the shell. Any evaporative water loss through the carapace during basking will be assessed by means of a small ventilated sweat capsule (Matsuura and Whittow, 1974) placed lightly on the surface of the carapace of captive basking turtles.

Meteorological measurements. Incident solar radiation, infra-red radiation (determined with a radiometer) from the sky and sand, wind velocity, air temperature, air humidity, and black globe temperature, together with the measurements described in the preceding paragraph, will permit the calculation of heat loss by evaporative and nonevaporative channels, between the turtle and its environment.

Significance

This study will, it is believed, make a significant contribution to our understanding of the ecology of basking sea turtles. It will also provide data on the bioenergetics of an important part of the sea turtle's life history.

References

- Balazs, G. H. and Ross, E. (1974). *Copeia*, 542.
 Boyer, D. R. (1965). *Ecology*, 46, 99.
 Cagle, F. R. (1950). *Ecol. Mon.* 20, 32.
 Hutchinson, J. C. D., Allen, T. E. and Spence, F. B. (1975). *Comp. Bioch. Physiol.* 52A, 343.
 Matsuura, D. T. and Whittow, G. C. (1974). Evaporative heat loss in the California Sea Lion and Harbor Seal. *Comp. Biochem. Physiol.* 48A, 9-20.

Budget justification

Fuel costs for boat--travel from Tern Island, French Frigate Shoals, the location of a Coast Guard Station, to nearby islands where the turtles bask, is by small boat.

Local travel--between Honolulu and Barbers Point Naval Air Station, departure point for French Frigate Shoals. To Sea Life Park and Waikiki Aquarium to study captive turtles. To purchase supplies.

Publication costs--page charges, \$150; reprints, \$200; preparation of slides and illustrations, \$150.

Fabrication--captive green sea turtles will haul out on ramps or sandy beaches created for them (Balazs and Ross, 1974).

G. CAUSEY WHITTOW

- Born: 28 February 1930, Milford Haven, Wales, Great Britain.
- Married: 4 June 1955 to Christina Sow Kheng Low of Singapore.
- Children: One daughter aged 15.
- Degrees and Professional Qualifications: B.Sc. (Honours) in Physiology, University College, London, England. 1952.
- M.I. Biol. England. 1953.
- Ph.D. in Physiology, University of Malaya, Singapore, 1957.
- F.L.S. England. 1976.
- Positions: Assistant Lecturer in Physiology, School of Medicine, University of Malaya, Singapore, 1952-1954.
- Lecturer in Physiology, School of Medicine, University of Malaya, Singapore, 1954-1959.
- Senior Scientific Officer, Department of Physiology, The Hannah Research Institute, Ayr, Scotland, U.K. 1959-1965.
- United States Public Health Service, National Institutes of Health, Post-doctoral Fellow in Physiology, Rutgers University, New Brunswick, New Jersey, U.S.A. 1961-1962.
- Associate Professor Physiology, Rutgers University, New Brunswick, New Jersey, 1965-1968.
- Professor of Physiology, School of Medicine, University of Hawaii, Honolulu, Hawaii, U.S.A. 1968-
- Visiting Professor of Physiology, Faculty of Medicine, University of Malaya, Kuala Lumpur, Malaysia. 1974-1975.
- Visiting Investigator, Dalton Research Center, University of Missouri, Columbia, Missouri. June 1976.
- Societies: American Physiological Society
American Society of Zoologists
Ecological Society of America
International Oceanographic Foundation
Association of Tropical Biologists

Publications (last 5 years)

Books

Editor:

- Whittow, G. Causey (1973). Comparative Physiology of Thermoregulation, Vol. III, Academic Press, New York.
- Whittow, G. Causey (1971). Comparative Physiology of Thermoregulation, Vol. II, Academic Press, New York.

Chapters in Books:

- Whittow, G. C. (1976). Effects of heat stress on the central circulation in the mammals. In Progress in Animal Biometeorology, ed. H.D. Johnson, Vol. 1, Part 1. Swets, Lisse.
- Whittow, G.C. (1976). Temperature regulation in marine mammals. In Progress in Animal Biometeorology, ed. H.D. Johnson, Vol. 1, Part 1. Swets, Lisse.
- Whittow, G.C. (1976). Regulation of body temperature. In Avian Physiology, ed. P.D. Sturkie, 3rd edition. Springer-Verlag, New York.
- Whittow, G.C. (1976). Energy metabolism. In Avian Physiology, ed. P.D. Sturkie, 3rd edition. Springer-Verlag, New York.
- Whittow, G.C., Matsuura, D.T. and Ohata, C.A. (1975). Physiological and behavioral temperature regulation in the California Sea Lion (Zalophus californianus). In Biology of the Seal, ed. K. Ronald Rapp. P-v. Reun. Cons. int. Explor. Mer. 169, 479-480.
- Whittow, G. Causey (1973). Responses to changes in ambient temperature: homiothermic animals. In Biology Data Book, ed. P.L. Altman and D.S. Dittmer, Vol. II, 2nd edition. Federation of American Societies for Experimental Biology, Bethesda.
- Whittow, G. Causey (1973). Evolution of thermoregulation. In Comparative Physiology of Thermoregulation, Vol. III. Academic Press, New York.

Whittow, G. Causey (1971). Ungulates. In Comparative Physiology of Thermoregulation, Vol. II. Academic Press, New York.

Scientific Papers in Journals:

Ebisu, R.J. and Whittow, G.C. (1976). Temperature regulation in the Small Indian Mongoose (Herpestes auropunctatus). Comp. Biochem. Physiol. 54A, 309-313.

Rahn, H., Paganelli, C.V., Nisbet, I.C.T. and Whittow, G.C. (1976). Regulation of incubation water loss in eggs of seven species of terns. Physiol. Zool. 49, 245-259.

Whittow, G.C., Scammell, C.A., Leong, Margaret, and Rand, D. (1976). Temperature regulation in the smallest ungulate, the Lesser Mouse Deer (Tragulus javanicus). Comp. Biochem. Physiol. 56A, 23-26.

Hampton, I.F.G. and Whittow, G.C. (1976). Body temperature and heat exchange in the Hawaiian Spinner Dolphin, Stenella longirostris. Comp. Biochem. Physiol. 55A, 195-197.

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Matsuura, D.T. and Whittow, G.C. (1975). Thermal insulation of the California Sea Lion during exposure to heat. Comp. Biochem. Physiol. 51A, 757-758.

Whittow, G.C., Szekerczes, J., Kridler, E., and Olsen, D.L. (1975). Skin structure of the Hawaiian Monk Seal (Monachus schauinslandi). Pacific Science 29, 153-157.

Costello, R.R. and Whittow, G.C. (1974). Oxygen cost of swimming in a trained California Sea Lion. Comp. Biochem. Physiol. 50A, 645-647.

Matsuura, D.T. and Whittow, G.C. (1974). Evaporative heat loss in the California Sea Lion and Harbor Seal. Comp. Biochem. Physiol. 48A, 9-20.

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- Shallenberger, R.J., Whittow, G.C. and Smith, R.M. (1974). Body temperature of the nesting Red-footed Booby (*Sula sula*). *Condor* 76, 476-478.
- Whittow, G.C. (1974). Marine mammals. *Mal. Vet. J.* 5, 157-161.
- Whittow, G.C., Hampton, I.F.G., Matsuura, D.T., Ohata, C.A., Smith, R.M. and Allen, J.F. (1974). Body temperature of three species of whales. *J. Mammalogy* 55, 653-656.
- Woods, Joseph J. and Whittow, G. Causey (1974). The role of central and peripheral temperature changes in the regulation of thermal polypnea in the chicken. *Life Sciences* 14, 199-206.
- Matsuura, D.T. and Whittow, G.C. (1973). Oxygen uptake of the California Sea Lion and Harbor Seal during exposure to heat. *Am. J. Physiol.* 225, 711-715.
- Woods, J.J. and Whittow, G.C. (1973). Cardiovascular response to blood withdrawal in the chicken: a "reactive error" in the determination of cardiac output. *Br. vet. J.* 129, 390-397.
- Lin, Y.C., Matsuura, D.T. and Whittow, G.C. (1972). Respiratory variation of heat rate in the California Sea Lion. *Amer. J. Physiol.* 222, 260-264.
- McGinnis, S.M., Whittow, G.C., Ohata, C.A., and Huber, H. (1972). Body heat dissipation and conservation in two species of dolphins. *Comp. Biochem. Physiol.* 43A, 417-423.
- Ohata, C.A., Matsuura, D.T., Whittow, G.C. and Tinker, S.W. (1972). Diurnal rhythm of body temperature in the Hawaiian Monk Seal (*Monachus schauinslandi*). *Pacific Science* 26, 117-120.
- Whittow, G.C., Matsuura, D.T. and Lin, Y.C. (1972). Temperature regulation in the California Sea Lion (*Zalophus californianus*). *Physiol. Zool.* 45, 68-77.

Hampton, I.F.G., Whittow, G.C., Szekerczes, J. and Rutherford, S. (1971).

Heat transfer and body temperature in the Atlantic Bottlenose Dolphin,
Tursiops truncatus. Int. J. Biometeor. 15, 247-253.

Kridler, E., Olsen, D.L. and Whittow, G.C. (1971). Body temperature of the
Hawaiian Monk Seal. J. Mammal. 52, 476.

Palumbo, N.E., Allen, J.F., Whittow, G.C. and Perri, S. (1971). Blood
collection in the sea lion. J. Wildlife Diseases 7, 290-291.

Whittow, G.C. (1971). Cardioacceleration in the ox (Bos taurus) during hyper-
thermia. Res. vet. Sci. 12, 495-496.

Whittow, G.C., Ohata, C.A., and Matsuura, D.T. (1971). Behavioral control of
body temperature in the unrestrained California Sea Lion. Comm. Behav.
Biol. 6, 87-91.

BIOGRAPHICAL INFORMATION

GEORGE HARVEY BALAZS

Born: 26 February 1943, Detroit, Michigan

Married: 9 March 1963 to Linda Rae Evans

Degrees: B.S. in Animal Sciences, University of Hawaii, 1967
M.S. in Animal Sciences, University of Hawaii, 1969

Professional Positions: Research Assistant, Department of Animal Sciences, 1967-1969
Jr. Marine Biologist (R2-8), Hawaii Institute of Marine Biology, University of Hawaii, 1971-present

Societies: Sigma Xi -- Research Society of North America
American Society of Ichthyologists and Herpetologists
Society for the Study of Amphibians and Reptiles

Services and Honors: Special consultant to the Survival Service Commission, International Union for Conservation of Nature (IUCN), for conference on commercial exploitation of marine turtles, November, 1974, Miami, Florida
Special consultant to the South Pacific Commission (Noumea) for evaluation of experiment turtle culture project in Fiji and the Cook Islands, February, 1977

- Publications:
- Balazs, G. H. (1976). Green turtle migrations in the Hawaiian Archipelago. *Biological Conservation* (Great Britain), 9:125-140.
- Balazs, G. H. (1976). Hawaii's seabirds, turtles, and seals. Dexter Press, N. Y., 32p (commercially published booklet with color plates).
- Balazs, G. H. (1976). Sea turtle conservation. *Elepaio, J. Hawaii Audubon Society*, 36(7):79-85.
- Balazs, G. H. and E. Ross (1976). Effect of protein source and level on growth and performance of the captive freshwater prawn, Macrobrachium rosenbergii. *Aquaculture*, 7:299-313.
- Balazs, G. H. (1975). Marine turtles in the Phoenix Islands. *Atoll Research Bulletin*, 184:1-7.
- Balazs, G. H. (1975). Green turtle's uncertain future. *Defenders*, 50(6):521-523.
- Balazs, G. H. and E. Ross (1974). Observations on the basking habit in the captive juvenile Pacific green turtle. *Copeia*, 2:542-544.
- Balazs, G. H. and E. Ross (1974). Observations on the preemergence behavior of the green turtle. *Copeia*, 4:986-988.
- Balazs, G. H., S. E. Olbrich and M. E. Tumbleson (1974). Serum constituents of the Malaysian prawn (Macrobrachium rosenbergii) and pink shrimp (Penaeus marginatus). *Aquaculture*, 3:147-157.
- Balazs, G. H., E. Ross and C. C. Brooks (1973). Preliminary studies on the preparation and feeding of crustacean diets. *Aquaculture* 2:369-377.
- Balazs, G. H. and E. Ross (1973). Green turtles reared in captivity. *International Turtle and Tortoise Society Journal*, 7(1):6-9, 33.
- Balazs, G. H. (1973). Status of marine turtles in the Hawaiian Islands, *Elepaio, J. Hawaii Audubon Society*, 33(12):1-5.
- Balazs, G. H. (1973). A simplified method for identifying experimental shrimp. *The Progressive Fish-Culturist*, 35(1):26.

UNIVERSITY OF HAWAII

Pacific Biomedical Research Center

November 1, 1976

Dr. Edwin W. Snider, Secretary
Committee for Research and Exploration
National Geographic Society
17th and M Street, N.W.
Washington, D. C. 20036

Dear Dr. Snider:

As you know, I am engaged in a study of the rare Hawaiian Monk Seal, with financial support from the Society. In the course of this work, I have become aware of a biological phenomenon of outstanding interest, and one which I believe should be investigated. I refer to the basking behavior of the Green Sea Turtles of the Northwestern Hawaiian Islands. The turtles come ashore during the day, and bask alongside the seals, for considerable periods of time, under extremely hot conditions. It is not known why they do so, but it is my contention that if we find out what happens to them, thermally, while they are basking, we shall be in a better position to decide why they bask. The phenomenon is presently believed to be unique to the Northwestern Hawaiian Islands.

Mr. George H. Balazs, of the University's Hawaii Institute of Marine Biology, has studied the Hawaiian Green Sea Turtle population for a number of years, making important contributions to our knowledge of their biology. He has some preliminary observations of the biology of basking and we should like jointly to seek funds to investigate this behavior further. One of Mr. Balazs' reprints, which has a photograph of basking turtles, is attached.

I should like to present to you, for your consideration, the following proposed arrangement: when my present grant from the National Geographic Society terminates in June, 1977, I should like to continue work on the Hawaiian Monk Seal, for another year, i.e., until June 1978, but with no further funding. However, I should like to retain the equipment that I have purchased with the grant, for another year. Before June 1977, Mr. Balazs and I will submit a new proposal to study the thermal ecology of basking Green Sea Turtles. The location of the study (French Frigate Shoals) will be the same as that for the Monk Seal investigation, and some of the equipment used in the Monk Seal study will be utilized for the turtle work. The two projects will proceed concurrently, from June 1977, making efficient use of funds. The problems presented by basking sea turtles and seals are strikingly analogous and they lend themselves to investigation by the same techniques.

Dr. Edwin W. Snider
November 1, 1976
Page 2

As you know, National Geographic photographers and writers spent some time at French Frigate Shoals earlier this year. They were guided and assisted, for part of the time, by Mr. Balazs, and I understand that an article on the Northwestern Hawaiian Islands will appear sometime next year. I am sure that the piece will include photographs of basking turtles and seals. Consequently, a relation may be established between the work that we propose and the activities of your Editorial Department.

Before we submit a formal proposal, I should like to have your response to these suggested arrangements. I shall also require a set of application forms.

With best regards,

Sincerely,

G. Causey Whittow

G. Causey Whittow
Professor of Physiology

George H. Balazs

George H. Balazs
Junior Marine Biologist
Hawaii Institute of Marine Biology

Attachment 2

A group of basking green sea turtles at French Frigate Shoals, Northwestern Hawaiian Islands.



Attachment 3

Basking green sea turtle and Hawaiian Monk Seal at French Frigate Shoals.



UNIVERSITY OF HAWAII

Pacific Biomedical Research Center

February 16, 1977

Dr. Edwin W. Snider
Secretary, Committee for Research
and Exploration
National Geographic Society
17th and M. Street, N.W.
Washington, D.C. 20036

Dear Dr. Snider:

As you will recall, we wrote to you, toward the end of last year, to explore the possibility of obtaining support from the Society for a study of basking green sea turtles. We are enclosing our proposal for such work, with this letter. There are three attachments to the proposal:

1. A copy of our letter dated November 1, 1976.
2. A print showing a group of basking turtles at French Frigate Shoals in the Northwestern Hawaiian Islands.
3. A print illustrating the analogous phenomena of basking sea turtles and Hawaiian monk seals. (The Hawaiian monk seal is the subject of a current study, by one of us, funded by the National Geographic Society.)

Sincerely,

G. Causey Whittow

G. Causey Whittow
Professor of Physiology

George H. Balazs
George H. Balazs
Junior Marine Biologist
Hawaii Institute of Marine Biology

Enclosure

UNIVERSITY OF HAWAII

Pacific Biomedical Research Center

May 21, 1977

Dr. Edwin W. Snyder, Secretary,
Committee for Research and Exploration,
National Geographic Society,
Washington D.C. 20036.

Dear Dr. Snyder:

We are delighted to know that our proposal to study the basking behavior of sea turtles has the approval of the National Geographic Society, and we should like to thank you and the Committee for your support.

We believe that the basking behavior of Hawaiian Green Sea Turtles is unique. In addition, by combining our resources, we shall not only be able to make efficient use of the Society's funds but also to keep the number of investigators working in the Hawaiian Islands' National Wildlife Refuge to a minimum, an important consideration in the management of the Refuge.

Enclosed are the Physical and Literary Release forms, which we have signed. We should like to draw your attention to the fact that we have altered the designation of one of us (G.H.B.), on the Literary Release form, to read "Co-Investigator", as this more accurately describes our joint participation in the project as co-investigators. We understand that you have your own terms and usage and we respect these. However, it would be helpful to us at the University, and we should appreciate it very much, if you could accept our change and, in addition, send us a further letter informing us of the award of the grant and mentioning the two of us by name.

Sincerely,

G. Causey Whitton

G. Causey Whitton
Professor of Physiology

George H. Balazs
George H. Balazs
Junior Marine Biologist
Hawaii Institute of Marine Biology

Enclosures

HELVIN K. PAYNE
CHAIRMAN
EDWIN W. SNIDER
SECRETARY

National Geographic Society
COMMITTEE FOR RESEARCH AND EXPLORATION
WASHINGTON, D. C. 20036

June 2, 1977

Dr. G. Causey Whittow, and
Dr. H. George Balazs
University of Hawaii
41 Ahui Street,
Honolulu, Hawaii 96813

Dear Drs. Whittow and Balazs:

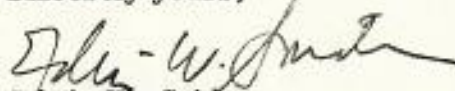
I send you herewith check of the National Geographic Society in the amount of \$3,660 in payment of our research grant to you in support of your study of thermal ecology of Hawaiian basking green sea turtles.

The check is made payable to you jointly to reflect the fact that you are co-principal investigators in this project.

We would appreciate having a brief accounting of our grant upon conclusion of this project. It need not be in great detail nor is it necessary that you send us the supporting receipts. It would, however, be well to keep such receipts for a while, especially for major expenditures, in case some question should be raised by our auditors.

If any funds remain unexpended upon completion of the project, they are to be returned to the National Geographic Society.

Sincerely yours,



Edwin W. Snider
Secretary, Committee for
Research and Exploration

EWS:mm
Enclosed: Check #34916

UNIVERSITY OF HAWAII

Pacific Biomedical Research Center

June 8, 1977

Dr. Edwin W. Snider
Secretary
Committee for Research and Exploration
National Geographic Society
Washington, D.C. 20036

Dear Dr. Snider:

Many thanks for your letter and enclosed check. We have started work on the sea turtles and we shall keep you informed of our progress.

Sincerely,

G. Causey Whitton

G. Causey Whitton
Professor of Physiology

George H. Balazs
George H. Balazs
Junior Marine Biologist
Hawaii Institute of Marine Biology

National Geographic Society

WASHINGTON, D. C.

No. 34916

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DATE TO THE ORDER OF

PAY

JUN 1 77

DR. G. C. WHITTON AND
DR. G. H. BALAZS

\$3660 DOLLARS .00 CENTS

NAT. GEOG. SOC.  3660 AND 00 CTS

FOR AND ON BEHALF OF NATIONAL GEOGRAPHIC SOCIETY.

The RIGGS NATIONAL BANK
of WASHINGTON, D. C.

WASHINGTON LOAN AND TRUST OFFICE
7 STREET AT NINTH, N. W.

William J. Hoffmann

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6. I also agree that, because of the foregoing considerations, for my own account I specifically release the National Geographic Society from any responsibility for loss or damage to my personal property arising out of, or connected with, or in any manner pertaining to the Expedition, or the preparations therefor.

George A. Balazs (SEAL)

WITNESS:

[Signature]
Alan K.H. Kam

PHYSICAL RELEASE

19 May, 1977

I, George H. Balazs of University of Hawaii

for one dollar (\$1.00) in hand, the receipt of which is hereby acknowledged and other valuable considerations, do hereby release the National Geographic Society, a corporation, for myself, my heirs, administrators, executors and assigns, from any and all liability for damages from illness, injury and/or death arising out of, or connected with, or in any manner pertaining to the National Geographic Society- Thermal Ecology of Hawaiian Basking Green
Sea Turtles Expedition.

George H. Balazs (Seal)

WITNESS:



Alan K.H. Kam

