REFERENCES

Altmann, S.A. (ed.). 1967. Social communication among primates. Chicago, University of Chicago Press.

Andrew, R.J. 1962. The situations that evoke vocalization in primates. Ann. N. Y. Acad. Sci. 102 : 296-315.

Andrew, R.J. 1963. The origin and evolution of the calls and facial expressions of the primates. Behaviour 20 : 1-109.

Armstrong, E.A. 1963. A study of bird song. London, Oxford University Press.

Bartholomew, G.A., and M. Rainy. 1971. Regulation of body temperature in the rock hyrax, Heterohyrax brucei. J. Mammal. 52 : 81-95.

Bastian, J.R. 1964. Primate signaling systems and human languages. In: I. DeVore (ed.). Primate behavior: field studies of monkeys and apes. New York, Holt, Rinehart & Winston.

Bedford, G.A.H. 1932a. Trichodectidae (Mallophaga) parasitic on Procaviidae. Proc. zool. Soc. Lond. 2 : 709-730.

Bedford, G.A.H. 1932b. A synoptic check-list and host-list of the ectoparasites found on South African Mammalia, Aves and Reptilia. Second edition. 18th Report of the Director of Veterinary Services and Animal Industry: Sections 1-10 : 478-479.

Bigalke, R.C., and J.A. Bateman. 1962. On the status and distribution of ungulate mammals in the Cape Province, South Africa. Ann. Cape Prov. Mus. 2 : 85-109.

Bondesen, P., and L.I. Davis. 1966. Sound analysis within biological acoustics. Natura Jutlandica 12 : 235-239.

Borror, D.J., and C.R. Reese. 1953. The analysis of bird song by means of a vibralyzer. Wilson Bull. 65 : 271-276.

Bothma, J. du P. 1963. The call of the rock dassie. Afr. Wild Life 17: 203.

Bothma, J. du P. 1964. A taxonomic revision of the extant Hyracoidea of Southern Africa. M.Sc. Thesis, Dept. Zool., Pretoria University.

Bothma, J. du P. 1967. Recent Hyracoidea (Mammalia) of Southern Africa. Ann. Transvaal Mus. 25 : 117-152.

Bothma, J. du P. 1971. Order Hyracoidea. In: J. Meester (ed.). Identification manual for African mammals. Washington, Smithsonian Institution.

Brand, D.J. 1963. Records of mammals bred in the National Zoological Gardens of South Africa during the period 1908 to 1960. Proc. zool. Soc. Lond. 140 : 617.

Brooks, R.J., and E.M. Banks. 1973. Behavioural biology of the collared lemming (Dicrostonyx groenlandicus (Traill)): An analysis of acoustic communication. Anim. Behav. Monogr. 6 : 1-83.

Brown, L.H. 1963. Observations on East African birds of prey. E. Afr. Wildl. J. 1 : 5-17.

Buettner-Janusch, J., V. Buettner-Janusch, and J.B. Sale. 1964. Plasma proteins and haemoglobins of the African elephant and the hyrax. Nature 201 : 510.

Burton, M. 1951. Hyrax: a natural odd-man-out. The Illustrated London News 218 : 58.

Busnel, R.G. (ed.). 1963. Acoustic behaviour of animals. Amsterdam, Elsevier.

Carpenter, C.R. 1969. Approaches to studies of the naturalistic communicative behaviour in nonhuman primates. In: T.A. Sebeok and Alexandra Ramsay (eds.). Approaches to animal communication. The Hague, Mouton.

Coe, M.J. 1962. Notes on the habits of the Mount Kenya hyrax (Procavia johnstoni mackinderi Thomas). Proc. zool. Soc. Lond. 138 : 639-644.

Churcher, C.S. 1956. The fossil Hyracoidea of the Transvaal and Taungs deposits. Ann. Transvaal Mus. 22 : 477-501.

Crook, J.H. 1970. Social organization and the environment : Aspects of contemporary social ethology. Anim. Behav. 18 : 197-209.

Dobroruka, L. 1973. Yellow-spotted dassie Heterohyrax brucei (Gray, 1868) feeding on a poisonous plant. Säugetierkdl. Mitt. 21 : 365.

Eismann, G. 1897. Der Kapische Klippenschliefer in der Gefangenschaft. Der Zool. Garten 39 : 118-120.

Fourie, P.B. 1972. A method for trapping the rock dassie (Procavia capensis). J. Sth. Afr. Wildl. Mgmt. Ass. 2 : 29-30.

Fox, H. 1933. Some notes upon the nature, health and maintenance of the hyrax. Proc. Amer. phil. Soc. 72 : 1-24.

Flower, S.S. 1932. Notes on the recent mammals of Egypt. Proc. zool. Soc. Lond. 1932 : 430-431.

Frings, H., and M. Frings. 1964. Animal communication. New York, Blaisdell Publishing Company.

George, H.M. 1874. Monographie anatomique des mammiféres du genre daman. Ann. Sci. nat. Zool. 1 : 1-260.

Glover, T.D., and J.B. Sale. 1968. The reproductive system of male rock hyrax (Procavia and Heterohyrax). J. Zool. 156 : 351-362.

Gray, J.E. 1933. Revision of the species of Hyrax, founded on the specimens in the British Museum. Ann. Mag. Nat. Hist. (4)1 : 35-51.

Greenewalt, C.H. 1968. Bird song: Acoustics and physiology. Washington, Smithsonian Institution.

Griner, L.A. 1968. The rock hyrax (Procavia capensis): a potential laboratory animal. Lab. Anim. Care 18 : 144-150.

Hahn, H. 1934. Die Familie der Procaviidae. Z. Säugetierk. 9 : 207-358.

Hall, K.R.L. 1965. Behaviour and ecology of the wild patas monkey, Erythrocebus patas, in Uganda. J. Zool. 148 : 15-87.

Hanse, W.A. 1962. Preliminary studies on the dassie. Its relation to farming and methods of control. Rep. Dep. Nat. Conserv. Cape Town 19 : 108-121.

Hendrichs, H. 1963. Wieder Kauen bei Klippschliefern und Känguruhs. Naturwissenschaften 50 : 454-455.

Hockett, C.F. 1958. A course in modern linguistics. New York, Macmillan.

Hockett, C.F., and S.A. Altmann. 1968. A note on design features. In: T.A. Sebeok (ed.). Animal communication. Bloomington and London, Indiana University Press.

Hoffmeister, D.F. 1967. Tubulidentates, Proboscideans and Hyracoideans. In: S. Anderson and J.K. Jones (eds). Recent mammals of the world. New York, The Ronald Press Co-pany.

Hvass, H. 1961. Mammals of the world. London, Methuen.

Jay, P. 1965. Field studies. In: A.M. Schrier, H.F. Harlow and F. Stollnitz (eds). Behaviour of non-human primates. New York, Academic Press.

Kiley, M. 1972. The vocalizations of ungulates, their causation and function. Z. Tierpsychol. 31 : 171-222.

Kingdon, J. 1971. East African Mammals. Vol. 1. London, Academic Press.

Kitching, J.W. 1966. A new giant Hyracoid from the Limeworks Quarry, Makapansgat, Potgietersrus. Palaeont. Afr. 9 : 91-96.

Kolbe, F.F. 1967. A plea for dassies. Afr. Wild Life 21 : 237-248.

Lancaster, J.B. 1968. Primate communication systems and the emergence of human language. In: P.C. Jay (ed.). Primates: studies in adaptation and variability. New York, Holt, Rinehart & Winston.

Lanyon, W.E., and W.N. Tavolga (eds). 1958. Animal sounds and communication. Washington, A. I. B. S.

Le Boeuf, B.J., and R.S. Peterson. 1969. Dialects in elephant seals. Science 166 : 1654-1656.

Lenneberg, E.H. 1969. Problems in the systematization of communicative behaviour. In: T.A. Sebeok and Alexandra Ramsay (eds). Approaches to animal communication. The Hague, Mouton.

Louw, E., G.N. Louw and C.P. Retief. 1972. Thermolability, heat tolerance and renal function in the dassie or hyrax, Procavia capensis. Zool. Afr. 7 : 451-569.

Louw, G.N. 1971. Water economy of certain Namib desert animals: Behavioural adaptation - the dassie or hyrax. S. Afr. J. Sci. 67 : 119-120.

Marler, P. 1965. Communication in monkeys and apes. In: I. DeVore (ed.). Primate behavior: field studies of monkeys and apes. New York, Holt, Rinehart & Winston.

Matthews, L.H. 1971. The life of Mammals. London, Weidenfeld & Nicolson.

Mendelssohn, H. 1965. Breeding the Syrian hyrax Procavia capensis syriaca Schreber 1784. Int. Zoo. Yb. 5 : 116-125.

Millar, R.P. 1971. Reproduction in the rock hyrax (Procavia capensis). Zool. Afr. 6 : 243-261.

Millar, R.P. 1972a. Reproduction in the rock hyrax (Procavia capensis) with special reference to seasonal sexual activity in the male. ~~D.Phil~~ Ph.D. Thesis, University of Liverpool.

Millar, R.P. 1972b. Degradation of spermatozoa in the epididymis of a seasonally breeding mammal, the rock hyrax, Procavia capensis. J. Reprod. Fert. 30 : 447-450.

Millar, R.P. 1973. An unusual light-shielding structure in the eye of the dassie, Procavia capensis Pallas (Mammalia: Hyracoidea). Ann. Transvaal Mus. 28 : 203-205.

Millar, R.P., and T.D. Glover. 1970. Seasonal changes in the reproductive tract of the male rock hyrax, Procavia capensis. J. Reprod. Fert. 23 : 497-499.

Millar, R.P., and T.D. Glover. 1973. Regulation of seasonal sexual activity in an ascrotal mammal, the rock hyrax, Procavia capensis. J. Reprod. Fert., Suppl. 19 : 203-220.

Moles, A.A. 1969. The concept of language from the point of view of animal communication. In: T.A. Sebeok and Alexandra Ramsay (eds). Approaches to animal communication. The Hague, Mouton.

Mollaret, H.H. 1962. Naissance de damans en captivité. Mammalia 26 : 530-532.

Moynihan, M. 1967. Comparative aspects of communication in new world primates. In: D. Morris (ed.). Primate ethology. London, Weidenfeld & Nicolson.

Murray, G.N. 1942. The gestation period of Procavia capensis. J. S. Afr. Vet. Med. Ass. 13 : 27-28.

Nassonow, N. 1895. Bemerkungen über die Lebensweise von Procavia (Hyrax) syriaca Schrb. Zool. Anz. 490 : 459-462.

O'Donoghue, P.N. 1963. Reproduction in the female hyrax (Dendrohyrax arborea ruwenzorii). Proc. zool. Soc. Lond. 141 : 207-237.

Owen, R. 1832. On the anatomy of the Cape hyrax. Proc. Comm. Sci. and Corresp. Zool. Soc. Lond. pp. 202-207.

Pallas, P.W. 1766. Miscellanea Zoologica, III Cavia capensis. Hagae Comitum, Apud Petrum van Cleef.

Pienaar, U. de V. 1964. The small mammals of the Kruger National Park - a systematic list and zoogeography. Koedoe 7 : 1-25.

Rahm, U. 1969. Notes sur le cri du Dendrohyrax dorsalis (Hyracoidea). Mammalia 33 : 68-79.

Reschke, B. 1960. Untersuchungen zur Lautgebung der Feliden. Diss. Humboldt Universität, Berlin.

Révész, G. 1944. The language of animals. J. Gen. Psychol. 30: 117-147.

Roche, J. 1962. Nouvelles données sur la reproduction des hyracoides. Mammalia 26 : 517-529.

Roche, J. 1972. Systematique du genre Procavia et das damans en general. Mammalia 36 : 22-49.

Sale, J.B. 1960. The Hyracoidea: a review of the systematic position and biology of the hyrax. J. E. Afr. Nat. Hist. Soc. 23 : 185-188.

Sale, J.B. 1965a. Gestation period and neonatal weight of the hyrax. Nature 205 : 1240-1241.

Sale, J.B. 1965b. Observations on parturition and related phenomena in the hyrax (Procaviidae). Acta Tropica 22 : 37-54.

Sale, J.B. 1965c. The feeding behaviour of the rock hyraxes (genera Procavia and Heterohyrax) in Kenya. E. Afr. Wildl. J. 3 : 1-18.

Sale, J.B. 1965d. Hyrax feeding on poisonous plant. E. Afr. Wildl. J. 3 : 127.

Sale, J.B. 1965e. Some aspects of the behaviour and ecology of the rock hyraces (genera Procavia and Heterohyrax) in Kenya. Ph.D. Thesis, London University.

Sale, J.B. 1966a. Daily food consumption in the hyrax. J. E. Afr. Nat. Hist. Soc. 25 : 215-224.

Sale, J.B. 1966b. The habitat of the rock hyrax. J. E. Afr. Nat. Hist. Soc. 25 : 205-214.

Sale, J.B. 1969. Breeding season and litter size in Hyracoidea. J. Reprod. Fert., Suppl. 6 : 249-263.

Sale, J.B. 1970a. The behaviour of the resting rock hyrax in relation to its environment. Zool. Afr. 5 : 87-99.

Sale, J.B. 1970b. Unusual external adaptations in the rock hyrax. Zool. Afr. 5 : 101-113.

Sebeok, T.A. (ed.). 1968. Animal communication. Bloomington and London, Indiana University Press

Sebeok, T.E., and Alexandra Ramsay (eds). 1969. Approaches to animal communication. The Hague, Mouton.

Siegfried, W.R., and R. Geldenhuys. 1965. Dassies killing crowned cranes. Afr. Wild Life 19 : 337-338.

Smith, Jane C. 1972. Sound production by infant Peromyscus maniculatus (Rodentia: Myomorpha). J. Zool. 168 : 369-379.

Smith, W.J. 1968. Message-meaning analyses. In: T.A. Sebeok (ed.). Animal communication. Bloomington and London, Indiana University Press.

Smithers, R.H.N. 1971. The mammals of Botswana. Museum Memoir No. 4. Salisbury, Trustees of the National Museums.

Struhsaker, T. 1967. Auditory communication among vervet monkeys (Cercopithecus aethiops). In: S.A. Altmann (ed.). Social communication among primates. Chicago, University of Chicago Press.

Sturgess, Irene. 1948. The early embryology and placentation of Procavia capensis. Acta Zoologica 29 : 1-87.

Swart, P.S. 1970. The vascular anatomy of the lower abdomen, pelvis and upper hindleg in Procavia capensis. Madoqua 2 : 3-18.

Taute, C.J. 1971. A new species of Prolinognathus (Anoplura: Linognathidae) and a redescription of P. leptocephalus (Ehrenberg, 1828) from the hyrax. Madoqua, Ser. I, No. 4 : 53-56.

Tavolga, W.N. 1968. Fishes. In: T.A. Sebeok (ed.). Animal communication. Bloomington and London, Indiana Unversity Press.

Taylor, C.R., and J.B. Sale. 1969. Temperature regulation in the hyrax. Comp. Biochem. Physiol. 31 : 903-907.

Tembrock, G. 1960. Spezifische Lautforme beim Rotfuchs (Vulpes vulpes) und ihre Beziehungen zum Verhalten. Säugetierkdl. Mitt. 8 : 150-154.

Tembrock, G. 1968. Land mammals. In: T.A. Sebeok (ed.). Animal communication. Bloomington and London, Indiana University Press.

Thomas, O. 1892. On the species of the Hyracoidea. Proc. zool. Soc. Lond. 1892 : 50-76.

Thorpe, W.H. 1961. Bird song: The biology of vocal communication and expression in birds. Cambridge, Cambridge University Press.

Thursby-Pelham, D. 1924. The placentation of Hyrax capensis. Phil. Trans. R. Soc. Lond. Ser. B, 213 : 1-20.

Turner, M.I.M., and R.M. Watson. 1965. An introductory study on the ecology of hyrax (Dendrohyrax brucei and Procavia johnstoni) in the Serengeti National Park. E. Afr. Wildl. J. 3 : 49-60.

Turner, W. 1875. Note on the placentation of hyrax (Procavia capensis). Proc. R. Soc. 24 : 151-155.

Van der Horst, C.J. 1941. On the size of the litter and the gestation period of Procavia capensis. Science 93 : 430-431 (1941).

Van der Poll, A. 1972. Klipdassen. Blijdorp Geluiden 20 : 4-6.

Visser, J. 1963. The black eagles of Zuurhoek. Afr. Wild Life 17 : 191-194.

Wagner, J.C., and V. Bokkenheuser. 1961. The mycobacterium isolated from the dassie Procavia capensis (Pallas). Tubercle 42 : 47-56.

Wagner, J.C., Buchanan, G., Bokkenheuser V., and Shirley Leviseur. 1958. An acid-fast bacillus isolated from the lungs of the Cape hyrax, Procavia capensis (Pallas). Nature 181 : 284-285.

Waring, G.H. 1966. Sounds and communications of the yellow-bellied marmot (Marmota flaviventris). Anim. Behav. 14 : 177-183.

Weitz, B. 1953. Serological relationship of hyrax and elephant. Nature 171 : 261.

Wells, L.H. 1936. The endocranial cast of recent and fossil hyraces (Procaviidae). S. Afr. J. Sci. 36 : 365-375.

Whitworth, T. 1954. The miocene hyracoids of East Africa. Foss. Mamm. Afr. 7. Brit. Mus. (Nat. Hist.) 1954 : 1-58.

Wislocki, G.B. 1928. The placentation of hyrax (Procavia capensis). J. Mammal. 9 : 117-126.

Wislocki, G.B., and O.P. van der Westhuysen. 1940. The placentation of Procavia capensis with a discussion of the placental affinities of the Hyracoidea. Contr. Embryol. 28 : 67-68.

ADDENDUM

Following discussion of this study with Prof. A. Alexander and Dr R.P. Millar, it was considered necessary to further clarify and support some of the statements made in the foregoing text. My thanks are due to them for advice on this matter.

The following questions are dealt with here:

1. How representative are the spectrograms selected to illustrate the different Procavia capensis sounds?

2. How are the sounds interrelated to form a continuum?

3. Can the statement that there is a tendency for the frequency and amplitude of the sounds to increase with increase in excitement (and vice versa) be quantitatively supported?

From the tape recordings and general observations on dassie sounds, it became apparent that some degree of variation in sound production and utilization exists among individual dassies. For that reason each sound recorded on tape was listed against the individual which emitted the sound and was temporarily assigned a name, e.g. grunt, growl-squeal, whistle, etc. A particular sound name (e.g. grunt) was then selected and two examples of the sound as performed by each individual dassie on different occasions, were spectrographically analysed. These spectrograms were visually inspected and the structural appearance most regularly displayed was consequently regarded as representative of the sound. The spectrogram closest resembling this general appearance was thus used for analytical and demonstrative purposes (see also p. 16). Following this procedure with all the sounds, every sound was again judged against the representative sound and permanently named or renamed if necessary. In this way intermediate sounds, i.e. sounds falling outside the range of individual variation but still displaying features of the distinct sounds, could also be determined. The intermediate sounds pointed to a gradual

change from one structural sound type to the next, i.e. a continuum of sound. Along this continuous line stages could be recognized where enough significant changes in structure (mainly in amplitude, frequency, length and tonality) were present to regard any stage as distinctly different from previous stages. These stages were regarded as distinct sounds, the interrelationships of which are illustrated in Fig. 19.

In Fig. 20 the frequency, amplitude and level of excitement associated with each dassie sound are compared. Although not strictly applicable to all dassie sounds, the general tendency for a higher level of excitement to be characterized by sounds showing a higher frequency and/or amplitude, is clearly illustrated. The similarity between the level of excitement and amplitude is especially noticeable. The amplitude categories (low, medium low, medium, medium high and high) were judged by ear according to relative loudness while the same categories for the levels of excitement were, according to the amount of locomotor and vocalizing activities involved, determined as follows:

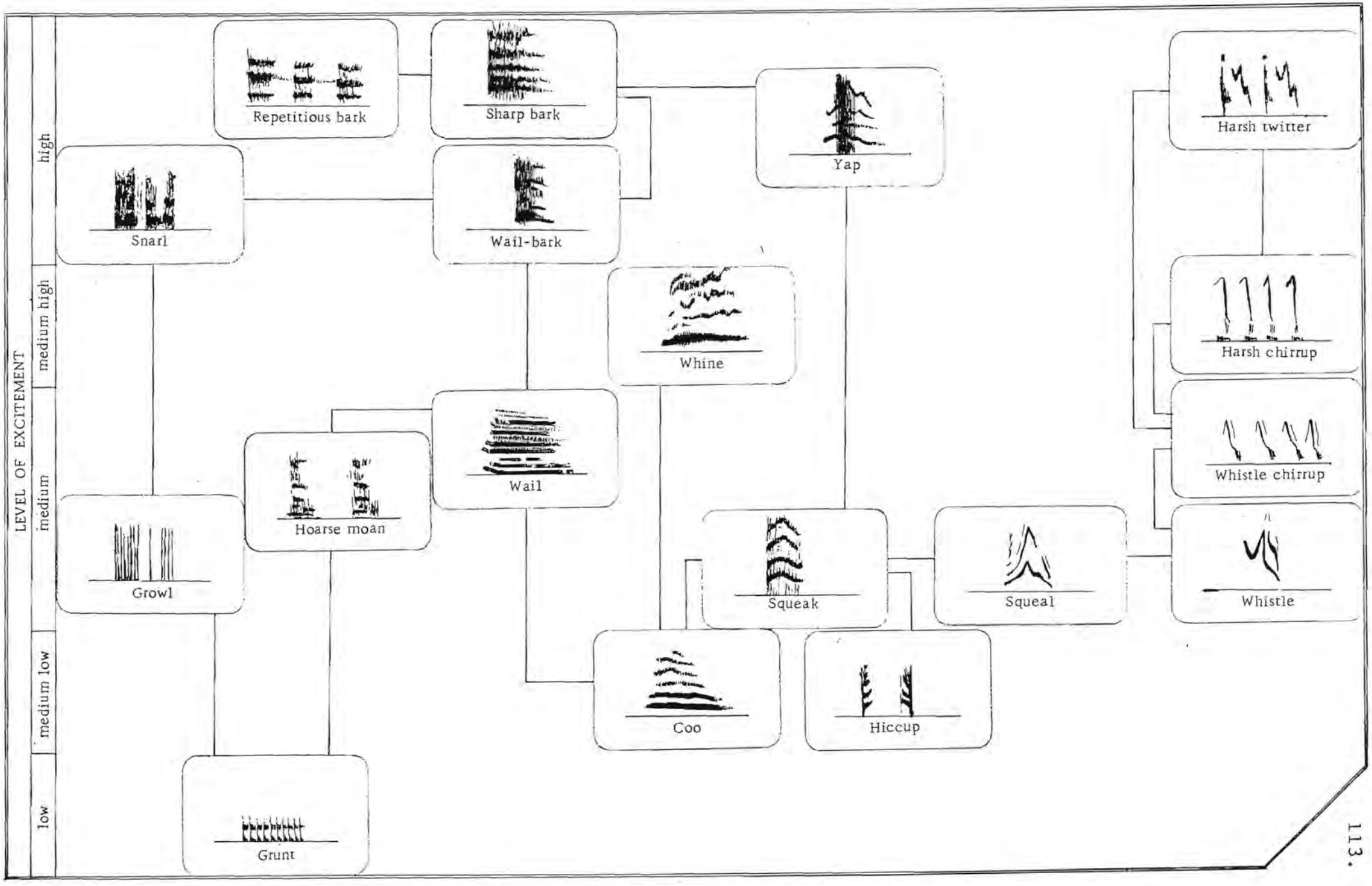
Low: Animal fairly relaxed, lying down or standing still. Casual raising or turning of the head in the direction of the stimulus, ears relaxed. Very little vocalizing activity.

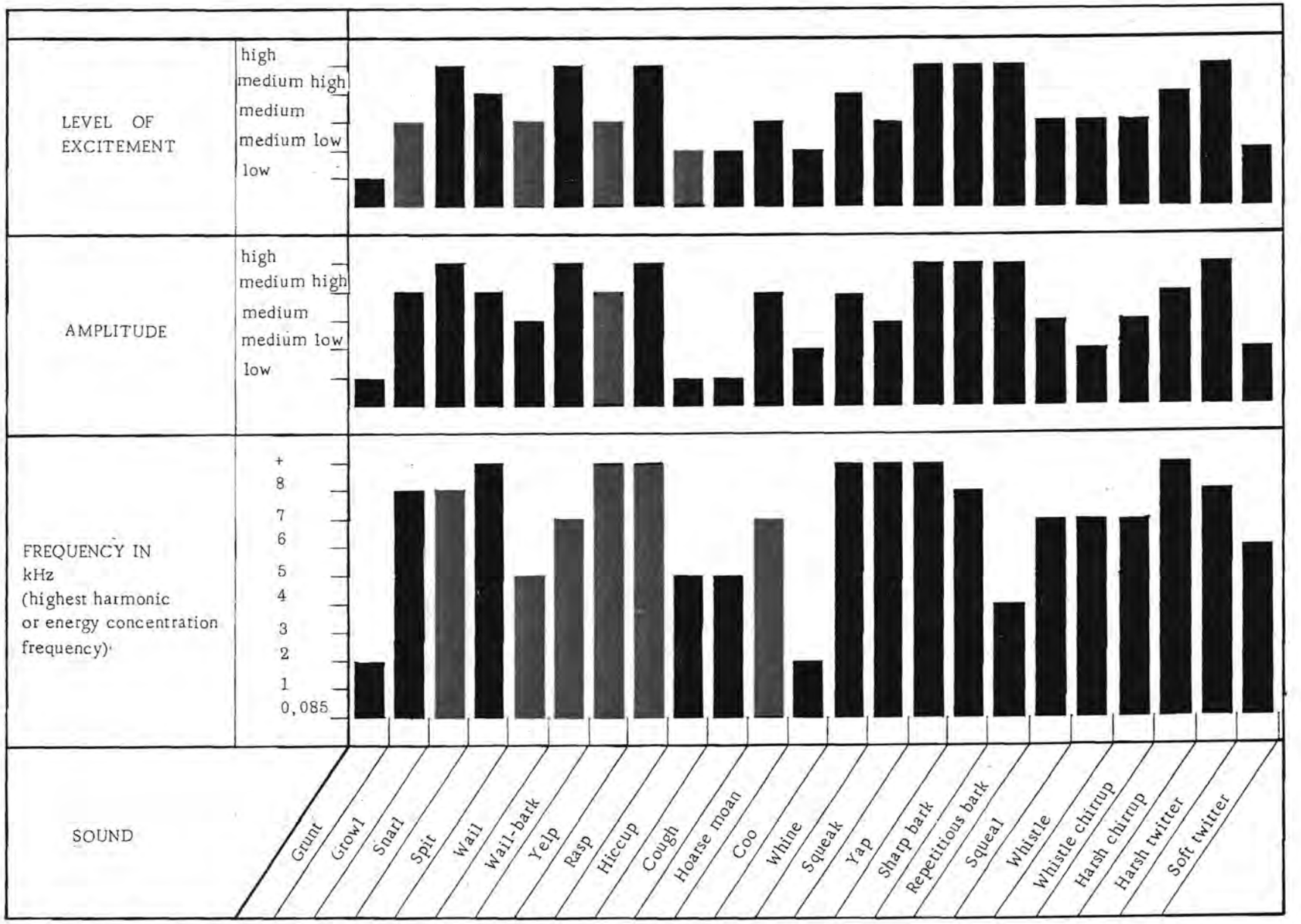
Medium low: Walking or casual feeding. Slight alertness indicated by frequent ear pricking or looking directly at the stimulus. Little vocalizing activity.

Medium: Increase in postural tonus, arching of back, raised head, body raised high on legs, dorsal spot flaring, retraction of upper lip, ears drawn flat against head. Jumping and moderately fast running over a short distance (usually not more than one or two metres). Increase in vocalization activity.

Medium high: Rapid locomotion over short distances and for short periods. Increase in vocalization activities with sounds repeated more often and at higher amplitudes.

Figure 19: Schematic illustration of the interrelationships of the adult Procavia capensis vocal sounds based solely on physical characteristics. It is suggested that these sounds form part of a continuum and that the level of excitement experienced by an animal in response to a particular stimulus determines the type and structure of the sound given. A rise in excitement does not necessarily imply that every sound along a particular line in the continuum will be given. Intermediate sounds, not included in the diagram, are represented by the interconnecting lines, which again does not imply pathways that have to be followed in situations, e.g. where the level of excitement rises or decreases.





High: Rapid locomotion for longer periods over greater distances. Maximum dorsal spot flaring, fighting and biting movements. Great vocalizing activity with more frequent repetition of sounds at high amplitudes and for longer periods.