Breaking the active galaxy speed record

from Andrew Lawrence

OBSERVATIONS of the variability of the light output of quasars and Seyfert galaxies have been of great importance as probes of the physical conditions in these 'active galactic nuclei'. New evidence has been reported[1] that the Seyfert galaxy NGC 6814 varies on the amazingly short time scale of 100 s, not only revealing the smallest dimensions so far for an active galactic nucleus, but at last beginning to place constraints on the physical processes responsible for the prodigious rate of energy output.

The time during which a body can change its behaviour by a significant amount is limited by the speed with which information can travel across the body; large bodies cannot alter as rapidly as small ones. The early realization that some quasars vary on a time scale of months[2] led astronomers to the astonishing conclusion that bodies that could fit comfortably between here and the nearest star are emitting as much energy as an entire normal galaxy. The 1970s saw the discovery that quasars and Seyfert galaxies expend a large fraction of their energy budgets as X rays. Several experiments found cases in which X-ray production varied over days and even hours[3-8]. Such considerations have led to the common belief that X rays relate most directly to the actual 'central powerhouse' of active galaxies. The volume of space involved in such a fast variation is far smaller than can be directly resolved with either optical telescopes or even the largest baseline radio interferometer. Variability studies may thus extract information unobtainable by any other method.

In 1978, controversy began over evidence presented by a group at Harvard[9] that the X-ray emission from the Seyfert galaxy NGC 4151 had varied on the remarkable time scale of 700 s. The data were rather marginal, and a group at the Goddard Space Flight Center (GSFC) published observations repudiating this suggestion[5]. However, a new study by Tennant *et al.*, from the same group at GSFC[1], has presented convincing evidence that a similar Seyfert galaxy, NGC 6814, varies its output on a time scale of 100 s.

Such very rapid variability tells us more than just the size of the radiating body. It places constraints on the parameters of models suggested to explain the activity of these galactic nuclei. Tennant *et al.* discuss several points in detail.

One hundred seconds corresponds to a light travel distance of 3×10^{12}cm. The X-ray emitter cannot be larger than this. If a massive black hole is at the heart of the business, it cannot be more massive than 10^7 solar masses ($M_\odot$); or the event horizon would be outside 3×10^{12}cm. On the other hand, to explain the observed luminosity by accretion of matter requires a black hole of at least 10^5 $M_\odot$ Such a system can have been radiating at its present luminosity for

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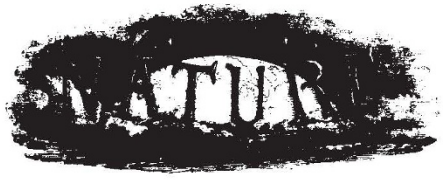

100 years ago

ILLUSTRATIONS OF NEW OR RARE ANIMALS IN THE ZOOLOGICAL SOCIETY'S LIVING COLLECTION

HARDWICKE'S CIVET-CAT (*Hemigalea Hardwickii*). — The Viverridae, or Civet-cats, form a well-marked family of carnivorous mammals peculiar to the tropics of the Old World, and mostly confined to Southern Asia and Africa, though one or two of them occur in the southern parts of Europe. One of the finest and largest of them is the True Civet-cat (*Viverra civetta*), from the anal glands of which the old-fashioned perfume known as civet is extracted, and the Genets, Ichneumons, and Mungooses are well-known members of the same family, examples of which are always to be seen in the Zoological Society's Collection.

Amongst the rarer and less familiar forms of the Viverrine groups is the very curiously-marked animal which we now figure (Fig. 17) from a specimen received by the Society in October, last year. Hardwicke's Civet, though first described by Dr. Gray so long ago as 1830, is a very scarce and little-known species, and the present example is believed to be the first of its kind ever brought alive to this country. In 1840 Müller and Schlegel gave an excellent figure and description of this animal, under the name of *Viverra boiei*, in their great work upon the Natural History of the colonial possessions of the Netherlands. Their specimen was obtained in South-Eastern Borneo by Herr Henrici, and sent alive to the Gardens of the Zoological Society of Amsterdam. Hence, after its death, it was transferred to the National Museum of Leyden. Müller adds that he never met with this Civet-cat himself during his extensive travels in the Eastern Archipelago, and had received no information as to its habits.

Hardwicke's Civet-cat was also figured and described by Eydoux and Souleyet in the "Zoology" of the voyage of the *Bonite* in 1841, under the name *Hemigate zebra*, but again without any information as to its habits, not even the locality of their specimen being stated.

So far as has been ascertained from the Zoological Society's living specimen, this animal is excessively shy and retiring in disposition, and apparently does not leave its retreat voluntarily except at night. When handled, it ejects a highly acrid and skunk-like secretion from its anal glands. The length of the body in the example figured is about 24 inches, and that of the tail about 18 inches.

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