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Frederick II of Hohenstaufen, Bergmann's rule and Aristotelian typology

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The phenomenon that warm-blooded vertebrates from cooler climates tend to be larger than individuals living in warm climates, later known as the Bergmann's ecogeographical rule was already known to Emperor Frederick II of Hohenstaufen in the thirteenth century. The rule is described in his falconry book *De arte venandi cum avibus*. Frederick based his rule on morphological and behavioural intraspecific differences he observed between hawks from the Mediterranean and those he received from North Europe, Iceland and Greenland. Frederick's contribution has remained virtually unacknowledged largely due to a translation error in a widely used edition of his book, where Frederick's conclusion of intraspecific variation in falcons has been translated as variation between species. Frederick also expressed early views against the Aristotelian species typology by introducing the concept of intraspecific variation in the geographical context.

Bergmann's rule is one of the most widely known "ecogeographical rules". It was established by the German zoologist Carl Bergmann (1847) and in its present form it states that individuals of warm-blooded vertebrates from cooler climates tend to be larger than individuals of the same species living in warmer climates. Both the validity of the rule and its physiological explanation have given rise to debate (see e.g. Scholander 1955, James 1970, Mayr 1970,

McNab 1971) which still continues (e.g. Lindstedt & Boyce 1985, Murphy 1985, Langvatn & Albon 1986, Geist 1987). James (1970) also draws attention to the fact that in his original text Bergmann actually states that the smaller species in a genus will occur in a warmer climate. The current form of Bergmann's rule, expressing intraspecific variation (*sensu* Mayr 1970), is thus a derivative of Bergmann's original work.

In this note we add some historical background to Bergmann's rule and point out that the intraspecific formulation of the rule had been already made by Frederick II.

The Bergmann's rule of Frederick II

Dementjev (1935) was the first to realise that Bergmann had predecessors. The first time Bergmann's rule appeared in the literature was in *De arte venandi cum avibus* by Frederick II of Hohenstaufen, the Holy Roman Emperor, who lived in 1194–1250. In chapter V of the second book (named *Accipitres*) he wrote "*Universaliter autem omnes aves rapaces quae nascuntur in septimo climate, et ultra, versus polum arcticum sunt maiores, fortiores, audaciores, pulciores, meliores et velociores quaelibet autem in specie sua*" (As a rule, rapacious birds born in the seventh climatic zone and still further north in the

direction of the arctic pole are larger, stronger, more fearless, more beautiful and gracious and swifter, but every one within its own species; *Codex Ms. Pal. Lat. 1071*). Frederick was obviously speaking of *intraspecific* variation, *not* of variation between species, as the chapter is translated in the widely used Wood and Fyfe edition of *The art of falconry* (1943).

Frederick's observation on size variation was not an anecdotal finding but a result of a long-term survey of hunting hawks. In the Middle Ages falconry was a popular hobby among nobles, and Frederick received hunting hawks at his court in Sicily from practically all parts of the world of that time, including Northern Scandinavia, Greenland and Iceland. He thus had an excellent opportunity to compare geographical differences in size, colouration and behaviour among his hawks. He concluded that the white race of the Gyrfalcon *Falco rusticolus* is the best hunting falcon. Frederick's falconry book contains detailed descriptions of five species of hawks and falcons, namely the Gyrfalcon, Saker Falcon *F. cherrug*, Peregrine *F. peregrinus*, Lanner Falcon *F. biarmicus* and Sparrowhawk *Accipiter nisus*. Furthermore, the excellent illustrations in the margins of the pages comprise a total of about 800 figures of 80 bird species.

Frederick II and the Aristotelian influence

The Aristotelian influence is evident when Frederick II reasoned why Bergmann's rule applies to birds: "*Maiores quia in septimo climate et ultra est frigus intensum, contemperans caliditatem intensam, quam habent ex eorum natura, et ex comtemperazione caliditatis augmentatur humiditas, et ex augmentatione humiditatis dilatantur membra, et sic efficitur corporis magnitudo*" (They are larger because, in the seventh climate and further north, the intense cold tempers their inherent intense heat, thereby increasing humidity, and because the augmentation of humidity enlarges their members, and in that way the magnitude of the body is effected).

However, what is most interesting, and apparently not noticed before in the literature, is that the outlook of Frederick upon the geo-

graphical variation of species was in clear contrast to the Aristotelian (typological or essentialist) species concept. This is shown in Frederick's statement: "*diversitas enim regionum, colorum et morum non facit homines aut animalia esse diverse speciei*" (but variation in colour, habits, and place of origin do not cause either men or animals to belong to different species). Frederick handled his specimens of birds which originated from separate areas, i.e. populations displaying geographical variation. In doing this, he carried out — to apply Mayr's (1982) expression — "the rejection of essentialism with its insistence of the constancy of the species essence", a method not consistently applied in European zoology until the 19th century. Frederick further expressed his reluctance to uncritically accept Aristotelian views. "*We don't follow the prince of philosophy in everything because he seldom or almost never treats the art of falconry, but we have loved it ever since we were young and still continue to do so*" (pp. 5–6). This love of falconry made Frederick an early proponent of empiricism, and *De arte venandi cum avibus* is actually the most important achievement in empirical zoology of the 13th century.

It is to be noticed that Frederick presented his views just before, or at the time when, the Aristotelian doctrine was formulated as a basis of Christian theology by Thomas Aquinas in his writings, or at least before the ecclesiastical reaction, in the later 13th century, against non-Aristotelian views which eventually confirmed the philosophy of Thomas Aquinas for centuries. For this reason the remarks of the emperor were forgotten.

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Selostus: Keisari Fredrik II Hohenstaufilainen, Bergmannin sääntö ja aristotelinen lajikäsitys

Bergmannin lain nimellä tunnettu ekomaantieteellinen sääntö toteaa kylmässä ilmastossa

elävien tasalämpöisten selkärankaisten olevan kookkaampia kuin lämpimillä leveysasteilla elävät lajikumppaninsa. Tämä väite esiintyy jo 1200-luvulla keisari Fredrik II Hohenstaufilaisen haukkametsästystä käsittelevässä teoksessa *De arte venandi cum avibus*. Fredrick II tuotti hoviinsa Sisiliaan suuria määriä haukkoja koko silloisesta tunnetusta maailmasta, mukaan lukien Pohjois-Skandinavian, Islannin ja Grönlannin. Vertaamalla näitä yksilöitä Välimeren alueelta pyydystettyihin, Fredrik II totesi pohjoisesta saapuvien haukkojen olevan isokokoisempia kuin eteläiset lajikumppaninsa. Tällä havainnolla Fredrik II kirjautuu ensimmäisten empiirikkojen joukkoon. Fredrik II:n prioriteetti on jäänyt laajalti huomaamatta, sillä eniten käytetyssä *De arte venandi cum avibus* -teoksen editiossa (Wood & Fyfe 1943) haukkojen lajien sisäinen kokomuuntelu on virheellisesti käännetty lajien väliseksi eroavuudeksi. Fredrikin teoksessa on myös ilmeisesti varhaisin tunnettu huomautus Aristoteleen typologista lajikäsitettä vastaan; Fredrik toteaa keräämiensä haukkojen lajien sisäisen maantieteellisen muuntelun.

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