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THE TAXONOMIC STATUS OF THE MEXICAN HOGNOSE SNAKE *HETERODON KENNERLYI* KENNICOTT (1860)

HOBART M. SMITH & DAVID CHISZAR
University of Colorado Museum
Boulder, Colorado 80309-0334

CURTIS M. ECKERMAN
Department of Zoology and Genetics
Iowa State University
Ames, Iowa 50011

HARLAN D. WALLEY
Department of Biology
Northern Illinois University
DeKalb, Illinois 60115

Abstract: Data on geographic variation of azygous and loreal scales in 389 specimens of *Heterodon n. nasicus* and *H. n. kennerlyi* indicate that these taxa are properly regarded as separate species: *H. kennerlyi* (97% with 8 or fewer azygous scales, and 93% with 2 or fewer toal loreals) and *H. nasicus* (1% and 17% respectively)

The nominal species *Heterodon kennerlyi* Kennicott (1860) has been accepted as valid at species or subspecies rank or as a synonym of *H. nasicus* Baird and Girard (1853), by various workers from the time of its description until 1939, after which the combination *H. nasicus kennerlyi* has been consistently used.

Actually, the earliest use of the currently accepted combination appeared in Bocourt (1886), and was followed by Cope (1900). The last usage of the name at the species rank was in Garman (1884a, b). However, Boulenger (1894) placed the name as an unrecognized junior synonym of *Heterodon nasicus*.

In spite of Cope's (1900) intervening use of the trinomial *Heterodon n. kennerlyi*, the three earliest Stejneger and Barbour checklists (1917, 1923, 1933) followed Boulenger's (1894) disposition of the name. In the fourth edition, however (Stejneger and Barbour, 1939), the name was admitted as a trinominal, presumably under the influence of Dunkle and Smith's (1937) resurrection of the name. The recent works by Boundy et al. (2000), Dixon (2000), Eckerman (1996), Walley and Eckerman (1999), Webb and Eckerman (1998), and Werler and Dixon (2000) have maintained that usage, as have all others.

Despite this apparent stability over the past 65 years, an undercurrent of uncertainty of rank has recently become apparent. Eckerman (1996), in his revision of the species, found no distinctive differences of *Heterodon kennerlyi* from *H. nasicus*, other than numbers of azygous and loreal scales. Nevertheless, he noted that he could not prove that *H. kennerlyi* was not a distinct species.

On the contrary, Boundy et al. (2000: 62) stated that the "nominal races in *Heterodon nasicus* undoubtedly represent arbitrarily delimited sections of continuous variation."

Platt (1969) concluded that, on grounds of clinal variation, the validity of *Heterodon n. gloydi* Edgren (1952) is questionable. Walley and Eckerman (1999), based on Eckerman (1996), placed *H. gloydi* as a junior synonym of *H. n. nasicus*, and we accept that conclusion. However, the range depicted for that subspecies in Werler and Dixon (2000) is, contrary to previous concepts (e.g. Dixon, 2000), limited to a dichopatric area in eastern Texas. With that range concept, *H. n. gloydi* should be re-evaluated and may be valid.

Heterodon n. kennerlyi, however, has long been regarded as distinctive from the rest of its species on the basis of having 6 or fewer azygous scales, the other subspecies having 9 or more. If confirmed, the difference is categorical.

Eckerman's data (1996), however, show that the hiatus in azygous counts does not exist, although it is nearly categorical. Another difference in loreal counts is very strong. For *Heterodon kennerlyi* , the azygous scale counts range 2–11 (M=3.1, N=152), of which only 3% of individuals have 9 or more, and the total loreal count is 0–6 (M=2.1, N=152), of which only 7% are 3 or more. In *H. nasicus*, the azygous scales range 8–27 (M=13.6, N=237), 99% of which are 9 or more, and the total loreals 2–9 (M=4.1, N=227), 83% 3 or more.

From these calculations we have excluded three old specimens (nos. 1253, 1285, 4860) in the USNM from "Arizona," with "110," 14 and 20 azygous scales and 4–5 total loreals, supposedly within the geographic range of *H. kennerlyi* but with scale counts outside the known range in that taxon. Similarly, we have excluded two specimens supposedly from within the geographic range of *H. nasicus*, but with characters outside the known range of that taxon; all are early USNM specimens, no. 1265, "Montana," with one azygous scale and 2 total loreals, and 1276, "Nebraska," with 0 azygous scales and 2 total loreals. All of the above are regarded as having erroneous locality data.

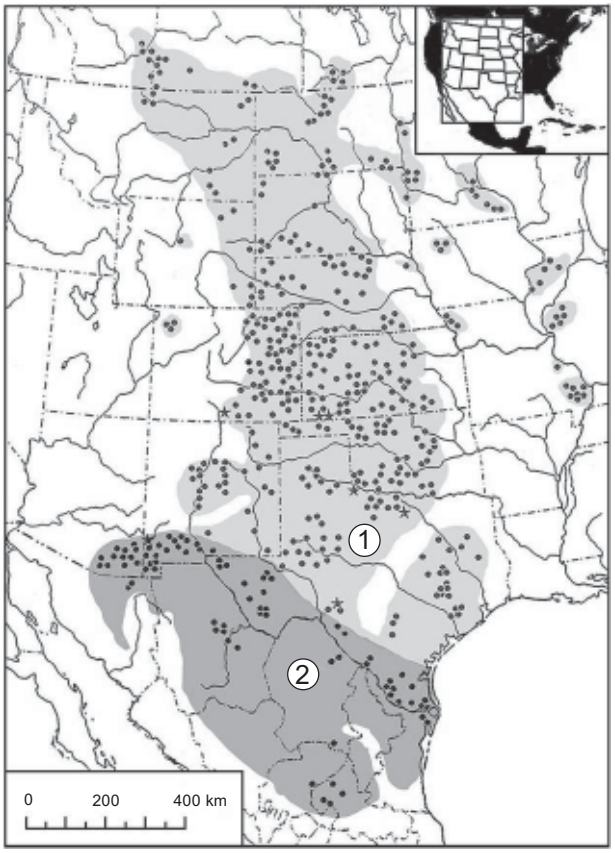

Figure 1. Distribution of *Heterodon nasicus* and its subspecies *H. n. nasicus* (1) and *H. n. kennerlyi* (2) as depicted in Walley and Eckerman (1999), courtesy SSAR and the authors stated. Stars indicate fossil sites, and the hollow circle the restricted (from "Rio Grande and Sonora") type locality (Smith and Taylor, 1950. Brownsville; Schmidt, 1953. mouth of the Pecos River) of *H. kennerlyi*. The type locality "Texas" of *H. nasicus* was restricted to Amarillo by Edgren (1952) and is not indicated.

The five *Heterodon kennerlyi* with 9 or more azygous scales are from Coahuila (1 with 10, in 11), southeastern Arizona (3 with 10–11, in 75), and one from Zacatecas (the only one of the subspecies with 9, in 2). All but the latter are from near the zone of parapatry between the two taxa, and are best interpreted as hybrids, not intergrades.

Among the three *Heterodon nasicus* with 8 azygous scales, two are from Colorado, and one from eastern Texas (Colorado Co.). All are far from the geographic range for *H. kennerlyi*, hence cannot be regarded as either intergrades or hybrids; they are extreme variants of the taxon.

To verify the impressions created by the analyses reported above, we conducted several regressions using STATVIEW. The overall goal of the regressions was to quantify the relationship between latitude and scale counts, and to separate linear from nonlinear components of the relationship. It is our contention that a linear relationship reflects clinal variation, whereas a significant nonlinear (i.e., quadratic) component reflects an element of variation that cannot be explained by clinal effects, and may therefore be taken as justification for taxonomic differentiation.

To accomplish these statistical analyses, we selected 150 specimens in the following manner. At each of 10 latitudes (from 27° to 45° in steps of two degrees) we randomly selected an average of 15 specimens, using as our criteria for inclusion that the specimen must have unambiguous data on azygous scale counts and unambiguous data on loreal counts (bilaterally). This procedure was followed, as opposed to selecting 150 specimens at random from our total set of 359, because the latter procedure would oversample the midlatitudes, where most specimens come from and would undersample the more extreme northern and southern latitudes from which we have fewer specimens.

After selecting our 150 specimens, a linear regression was executed, treating latitude as the predictor and number of azygous scales as the dependent variable. Then a polynomial regression was executed on the same dependent variable, but

including both the linear and quadratic effects of latitude. The R^2 for the linear regression was 0.603, whereas R^2 for the polynomial regression was 0.637. The difference between these values was significant (F = 13.62, df = 1,147, P<0.01), indicating that the quadratic component of latitude accounted for a part of the variance in azygous scale counts that the linear regression missed. In other words, there was a significant discontinuity in azygous scale counts such that counts at 27°, 29°, and 31° were not on a simple linear cline with the counts at higher latitudes, but were separated from the higher latitudes by a significant inflection.

The same types of regression were carried out for the total number of loreal scales (i.e., number on right side plus number on left side). The R^2 for the linear regression was 0.649, and the R^2 for the polynomial regression was 0.651. In this case the difference between the two coefficients of determination was not significant (F = 0.43, df = 1,147, P<0.05). Accordingly, variation in loreal counts was entirely linear and, hence, clinal.

We wish to underscore several points. First, both azygous and loreal counts separate *Heterodon kennerlyi* from *H. nasicus*, and these respective variables are highly correlated with each other (r = 0.691, df = 148, P=<0.01). Second, because loreal counts are clinally related to latitude, this variable cannot be used of itself for separating the two taxa. Third, even though the two variables are strongly correlated, azygous counts contain a significant quadratic component in their relation with latitude, whereas loreal counts do not. The former variable, therefore, provides justification for specific separation of *H. kennerlyi* from *H. nasicus*.

These two taxa fall into the category of semispecies of Mayr (1963) and Mayr and Ashlock (1991), at least some examples of which may be taxonomically regarded as species. The pattern of geographic variation and high degree of distinction of the two taxa of present concern we regard as consistent with species rank.

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