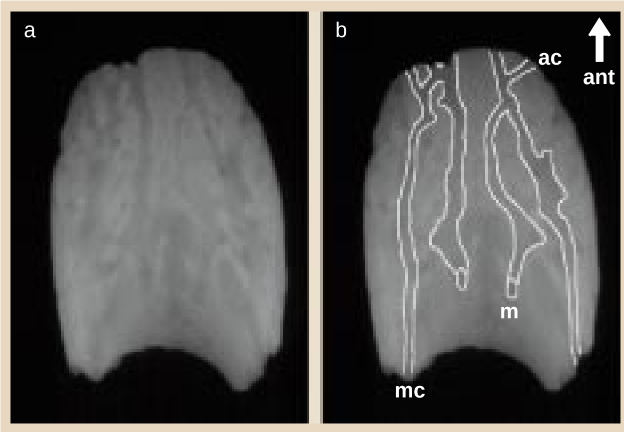

Figure 2 X-rays of the dorsoventral view of the Lance Formation parrot mandibular symphysis. **a**, The mandibular symphysis. **b**, The mandibular symphysis with the neurovascular canals outlined. The median neurovascular canals extend from the median foramina to the anterior end of the symphysis and intersect the meckelian canals. Accessory canals extend from the median canals, anterior to the intersection with the meckelian canals, anterolaterally to the tomial crest. This results in a K-shaped neurovascular canal pattern in the right side of the symphysis, with a mirror image of the pattern in the left side. Ant, anterior; other abbreviations are as in Fig. 1.

are absent in extant parrots and this specimen; the caenagnathid median symphysial foramina are located anterior to the position seen in parrots and this fossil[9]. The K-shaped neurovascular canal pattern (Fig. 2) and deeply concave symphysis seen in this specimen are apparently derived characters found only in Psittaciformes. The rounded rostral end of the symphysis, the deeply concave symphysis (compared with most Psittaciformes) and the concave tomial crest are most common in Loriidae, but also occur in some macaws and other psittacids.

The discovery of this parrot in the Lance Formation indicates that the lineage leading to the parrot crown group was present by the end of the Cretaceous. If this parrot were a lory, as suggested by its morphology, the most recent common ancestor of the psittaciform crown group would be placed in the Cretaceous[10], as supported by molecular data[11]. The occurrence of a parrot in the Cretaceous implies the presence of other closely related bird taxa in the Cretaceous, as also predicted by molecular divergence data[7,8]. These data also indicate that modern bird groups, including parrots, may have been relatively unaffected by the mass extinction at the end of the Cretaceous period.

Thomas A. Stidham

Department of Integrative Biology, Museum of Paleontology, and Museum of Vertebrate Zoology, University of California, Berkeley, Berkeley, California 94720, USA

e-mail: furcula@socrates.berkeley.edu

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Hydrologic cycle explains the evaporation paradox

The evaporation of water, measured using evaporation pans, has been decreasing in the past few decades over large areas with different climates. The common interpretation is that the trend is related to increasing cloudiness, and that it provides an indication of decreasing potential evaporation and a decreasing terrestrial evaporation component in the hydrologic cycle. Here we show that, although these studies are valuable, pan evaporation has not been used correctly as an indicator of climate change.

At first glance, reports of decreasing pan evaporation in European Russia, Siberia and the western and eastern United States[1], India[2] and Venezuela[3] are paradoxical. They are hard to reconcile with well-substantiated increases in global precipitation and cloudiness[4], which would normally require more surface evaporation as the only source of atmospheric water vapour, rather than less. They also run counter to predictions of increasing evaporation[5], as one of the more robust outcomes of radiative forcing, resulting from increasing atmospheric CO_2 in global circulation model calculations.

We resolve this paradox by demonstrating that, in non-humid environments, measured pan evaporation is not a good measure of potential evaporation; moreover, in many situations, decreasing pan evaporation actually provides a strong indication of increasing terrestrial evaporation.

The evaporation from a pan, E_{pa}, can be used as a good indicator of the evaporation, E, from the surrounding environment, but only when land-surface moisture is in ample supply; this normally involves multiplication by a 'pan coefficient' a of order one, depending mainly on pan type[6]. The evaporation from any large uniform land surface, with adequate moisture so available energy is the limiting factor, is usually referred to as potential evaporation, E_0. The actual evaporation from a well-watered surface is $E = E_0 = aE_{pa}$. Whenever the land-surface moisture becomes limiting and insuffiecient to sustain E_0, the actual evaporation, E, decreases below E_0 and the energy not used up by E manifests itself as an increase in sensible heat flux ΔH, such that $E = E_0 - \Delta H$. This in turn causes aE_{pa} to exceed E_0, or $aE_{pa} = E_0 + b\Delta H$, where b is another coefficient slightly larger than one, again depending mainly on pan type. Now aE_{pa} no longer provides a direct measure of E_0, so it is more appropriately called 'apparent' potential evaporation.

The main point is that E and E_{pa} exhibit complementary rather than proportional behaviour; indeed, for instance in the extreme case of a desert environment, E is zero, whereas E_{pa} is at its maximum. The idea of a complementary relationship between actual evaporation and apparent potential evaporation is not new[7], and it has stimulated advances in the estimation of terrestrial evaporation[8–10]. In the case of a pan filled with water and placed in a region with less than adequate ground wetness to sustain E_0, elimination of ΔH in the above yields $E = [(1 + b)E_0 - aE_{pa}]/b$.

Because a and b are of order one, this equation indicates how the observed[1–3] decreases in pan evaporation, E_{pa}, can be interpreted as evidence for increasing terrestrial evaporation, E, in those regions. This is consistent with data[4,11] indicating an intensifying hydrologic cycle in large regions: increasing precipitation leads to increasing surface run-off and soil wetness, which in turn generates more evaporation, and so on.

W. Brutsaert*, M. B. Parlange†

**School of Civil and Environmental Engineering, Cornell University, Ithaca, New York 14853, USA*

†Department of Geography and Environmental Engineering, Johns Hopkins University, Baltimore, Maryland 21218, USA

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