

THE PARA-TYMPANIC ORGAN of VITALI: the challenge of bird sensory physiology.

by Enrico Cavina m.d.

Posted: 26 January 2016

www.labeccacciascientifica.it – <http://www.ilcolombaccio.it> (*Colombaccio scientifico*)

Corresponding Email : ecavinaster@gmail.com // ecavina@hotmail.com

ABSTRACT: *On the basis of the preceding paper ([Cavina, 2014](#)) concerning Eurasian Woodpigeons' autumn migration, we analyzed abiotic factors on the origin Scandinavian-Russian breeding areas for four more bird species in addition to the Woodpigeon. We have selected 60 migratory mass peaks of transit of the Eurasian Siskin, the Chaffinch/Brambling, the Common Starling, the Common Woodpigeon and the Barnacle Goose. The detailed relationship between mass take-off and changes in Atmospheric Pressure (plus other abiotic factors) 48-12 hours before starting has been analyzed .*

- (A) – 6 peaks not significant
- (B) – 6 peaks moderately significant (7-10 hPa difference)
- (C) – 48 peaks strongly significant (10 – 20 hPa difference)

The role of the Para-Tympanic Organ of Vitali (PTO) is underlined and further investigated.

GRAPHICS draft at :

https://photos.google.com/share/AF1QipM79yvIsGsLOiiwU_wuU3evW2-Kpqr1jTfMZwQ6dw6zRUS44mmb0S2dA2uCXp5Ag?key=QXFxeDMzVUV0WTcxbnNlRG43RlJhYjJOcXlRbnh3

(copy/paste)

THE PARA-TYMPANIC ORGAN of VITALI: the challenge of bird sensory physiology.

1. INTRODUCTION

Giovanni Vitali reported the discovery of Paratympanic Organ (PTO) in two papers (1911-1912). The history of PTO (<http://thewildlifewriter.blogspot.it/2013/09/skyscanner.html>) through a Century despite many research efforts is still on the point “the presumed barometric sense of hundreds of billions of living birds have failed to receive the recognition it deserve. Conclusive evidence of the function of PTO remains a formidable challenge in vertebrate sensory physiology” (Giannessi *et al*, 2013) and it presents “a formidable challenge for future research to overcome” (O’Neill, 2013).

The question “Do birds use barometric pressure to predict weather conditions” (Breuner *et al*, 2013) remains unresolved to all appearances despite the well known axiom “*the birds predict bad weather*” firstly related to migratory birds .

A recent paper (Metcalf *et al*, 2013) based on experimental method (pressure chamber of a hypobaric climatic wind tunnel) affirms that the results “*indicate that white-throated sparrows can facultatively adjust their behaviour in direct response to changing barometric pressure and temperature*”. Many others scientific papers have focused the question particularly on the role of low atmospheric pressure (incoming bad weather) and seldom on the role of increasingly high atmospheric pressure changes . The research relating PTO and wild migratory birds’ behaviour is very poor or absent. It seems to us that no research has considered the opportunity to study the behaviour of migratory birds in species starting the migration – very often- by mass take-off from breeding and/or stop-over sites , and related abiotic factors influencing the decision making to suddenly commence flying during migration.

Our paper (Cavina, 2015) is testimonial of our evidence based interest on the item and related details. The “Conclusions” of that paper say:

If you want to compare the data obtained in Sweden (area of first take-off) and France (take-off area after stop) and Italy (transit area after stop-over) prevails in a substantially similar effect (numerical and statistical) about the abiotic factors that may have influenced the decision of the take-off : no significant differences between the three areas about almost all factors considered . As for the raising or "overhang" of the atmospheric pressure in the hours (36h / 24 / 18 h) prior to the take-off, this increase is still a constant (Sweden 92.62% - 92.85% France) before a true peak migration and quantification of differences can only detect a higher percentage of increase in the hours further away (48-24 h) prior to take-off in France (73.80%) than in Sweden where at this time the remote 'incidence is only 27.65%, while in the two areas in the "18h" before takeoff , the incidence is 78.72% (Sweden) and 76.19% (France). Always interpreted in absolute terms of hypothesis would be the following : raising stimulates the take-off more powerfully and more quickly acclimated birds in a long time in the nest, while the stimulus is more long-term (1-2 days. before) the birds that have long been in migration and stop-over..A regardless of this interpretation and assumptions, it is important to note that the increase is constant over 90% in the peak mass migration.

The set of data - here in the form of simple raw numbers and percentages not elaborated in strictly statistical, and then ultimately understandable - suggests the desirability and / or the possibility of

in-depth analysis designed to identify integrations (day a day / hour a hour) with other abiotic and biological factors (as algorithms, equations, formulas, statistics, mathematical indices of analysis and / or forecast)

The extension of this method of analysis (ornithology - meteorology) to other areas of nesting and transit (possibly in the spring) may provide additional contributions to the understanding of the phenomenon of migration, deepening the analysis in climatological terms, so now present seasonal changes in the increasingly looming and influential on the environment.

Verification "live" directly in the field in 2014, about migration in Europe and particularly in Italy - as expressed in the "Updating spatial and temporal Research" - gave full confirmation of the results obtained with the global search retroactive.

Finally, we emphasize that the sensor terminal of the changes in atmospheric pressure can be easily detected in the organ Para-Tympanic (PTO) Vitali, which studied for the first time by Vitali in Italy in the early decades of the last century, still the subject of extensive research morphological and functional :if "the finger pressing" can be discerned in the changes of atmospheric pressure (the "overhang"), "click" on which the press is probably the Paratympanic organ of Vitali, having to consider all the neuro-functional integration with the adjacent structures in the inner ear (Lagena, vestibular apparatus) until the centers of the Brain and Cerebellum. To explain all that we have shown in this retrospective study is essential that there is a definite anatomical basis barometer understood as "organic".

We have also discussed (nov.2014) “ WHY ? “ the relationship with High A.P. (Atmospheric Pressure) and we concluded “*The most plausible explanations ("WHY?") remain the "physical" little or no turbulence, the best condition for flying wing aerodynamics, less fatigue and less energy consumption resulting there from.*”

2. MATERIALS and METHODS

At present time , to put better force on the results about the Eurasian Common Woodpigeon's (*Columba palumbus*) migration , we have extended the retroactive analysis on other species of migratory birds during autumn migration , considering others elements :

- safe migrations' counts as by Falsterbo Observatory's Archives (licensed to work over the Falsterbo data)
- choice of 5 species (woodpigeon included) mostly observed by records during 20 years
- choice of 60 peaks' days in selected years including 2015
- dimensional sizes of the birds (very little,little,medium,big) and related supposed size of PTO and the “body” in front of weather
- safe access (licensed) to data's safe Archives of Weather History on origin and transit areas
- reports on seasonal migrations as by Falsterbo Observatory

On this basis we have extracted evidence-based results by the same methodology as in the preceding work involving hundreds of paper-card records of peaks and meteorological data.

The selected years –with mostly yearly transit – have been extracted from a list of 43 years recorded on the Falsterbo Archives from 1973 until 2015 . The abiotic factors listed in Weather History web-cards were analyzed in the “origin” (mostly breeding) areas 0 – 400 km North – North East from Falsterbo, and 2000 Km East (coasts of North Russia) regarding Barnacle Geese , considering in this case,supposed long distance flies after takeoff.

We have identified 60 peaks (one peak in one or more per day) summarised as following :

- 5 peaks Eurasian Siskin - *Carduelis spinus* – transit more than 10.000 x day
- 17 peaks Caffinch –*Fringilla coelebs* / Brambling –*Fringilla montifringilla* transit more 40.000 x day
- 8 peaks Common Starling –*Sturnus vulgaris* – more than 10.000 x day
- 15 peaks Common Woodpigeon *Columba palumbus* – transit more than 40.000 x day
- 15 peaks Barnacle Goose *Branta leucops* – transit more than 10.000 x day

3. RESULTS

The relationships between A.P.jumps (12-24-36-48 h. before takeoff) and the day (mostly first day) of the peak were :

- 6 not significant
- 6 moderately significant (7-10 hPa increases)
- 48 strongly significant (more than 10 hPa differences)

Some events must be underlined :

- most important peaks happened after a A.P. jump more than 15 hPa
- in two cases identified as not significant the absence of a A.P. jump was related to a basic permanent High A.P. (more than 1020 hPa) on the area
- correlated downing of temperature was significant for Barnacle Geese and occasionally for others birds
- prevalent winds from S – SE were related to little -size-birds
- prevalent winds from N-NE were related to medium/big size birds
- Moon surface illuminated more than 40 % happened in 60 % of peaks
- the peaks are often related to events of mass takeoff of birds' populations mostly migrating by big or very big flocks starting from nesting or stop-over sites and flying at prevalent high altitude on corridors probably chosen depending on isobars (supposed altimetrical function of PTO)

Many data and graphics (including Temperature , A.P. , Wind force, Wind direction and others available navigating in Weather History, day by day, week by week , month by month and also hour by hour) are illustrated in a collage/draft available (direct click or Copy/paste in Google research-window) for the 5 species of related Birds

https://photos.google.com/share/AF1QipM79yvIsGsLOiiwU_wuU3evW2-Kpqr1jTfMZwQ6dw6zRUS44mmb0S2dA2uCXpN5Ag?key=QXFxeDMzVUV0WTcxbnNlRG43RIJhYjJOcXlRbnh3

(If it does not load you can request it at ecavinaster@gmail.com.)

4. DISCUSSION

Complete analysis of others abiotic factors has offered same results of the basic paper “Decision making of autumn migrations of woodpigeons (*Columba palumbus*) in Europe: analysis of the abiotic factors and atmospheric pressure changes” -

<http://www.scienceheresy.com/ornithologyheresy/index.html>

Obviously all the specific considerations must be related also to the biotic factors preparing the body of birds to be mature for the migration .

We would like to underline the present retroactive research/analysis regarding :

-a total of 55.600.080 migratory birds recorded in 43 years (1973-2015)

-a total of 13.011.507 birds selected on 60 migratory peaks in 5 selected years (2001-2015) for 5 species

The present study confirms the results reported in the 2014 paper , regarding the migration of Woodpigeons in Europe .

Growing up of Atmospheric Pressure 48 - ...-12 hours before takeoff is a constant physical factor , probably essential – not alone - to command the migration timing .

Nocturnal Migration

The present study concerns birds mostly migrating during the day-light but often integrating the migratory journey flying also during the night .

We can extend present methodology of retroactive research also on nocturnal migrating birds – often migrating alone or little group - but we must consider the difficulties to obtain safe counts and related peaks .

At present time we have probative sporadic elements concerning peaks of arrivals and movements of Eurasian and American Woodcocks , birds usually starting at first hours of the night and arriving last hours of the night or first of the day (Birtas P. et al. , 2013). Few collected data confirm the behaviour of diurnal birds also for nocturnal birds , relating the A.P. growing up with the decision making of the migratory takeoff and others abiotic factors . Very probably we can expect better study's opportunities by the recent methods of satellite monitoring of migrating birds .

Some years ago a similar study

*(<http://rspb.royalsocietypublishing.org/content/276/1656/447>) over godwits (*Limosa lapponica*) has evidenced data connecting the timing of departure from Alaska depending on the regular incoming of Aleutine Cyclone with Low A.P. and North winds , but the birds (9) (*Scolopacides as woodcocks*) departed few hours after the temporal growing up of A.P. then flying inside favourable corridors of High A.P. during long- distance (6-9 days/nights) fly over Pacific Ocean arriving directly in New Zealand without stop-over .*

*Direct personal occasional experience could be reported : 29-30 September 2014 we have observed a peak of nocturnal migrating quails (*Coturnix coturnix*) arriving in East Bularia from Black Sea-Ukraina areas after 12h of jump of High A.P.*

Probably better studies could be performed on the base of Radar data during migrations of birds in North and Baltic Sea .

Concluding we can strongly suspect that the nocturnal migrating birds have the same behaviours of diurnal migrating bird , concerning the suspected PTO answers to the rapid changes of A.P.

5. CONCLUDING COMMENT

Taking knowledge of the incoming stable atmospheric status – announced by the jump of A.P. – on the base of best atmospheric conditions able to facilitate the aerodynamics of long- distance migratory flies during the next days and nights , the birds start .

Very probably they use also the altimetric function of PTO suggesting to them the best corridors in which they can fly with regard to favourable winds at altitude, also modifying the genetic migration's routes to avoid bad flying conditions. An example - based on satellite telemetry - has been recently reported at <http://thewildlifewriter.blogspot.it/2013/09/skyscanner.html> .

Now we can return to the comment of Giannessi F. *et al* (2013) as reported in the introduction : “ *the presumed barometric sense of hundreds of billions of living birds have failed to receive the recognition it deserve. Conclusive evidence of the function of PTO remains a formidable challenge in vertebrate sensory physiology.* It is clear for us that barometric sense of birds plays a fundamental role to decide the massive migration take-off, also integrating the presumed altimetric function to chose best atmospheric routes.

Recent researches , studies and reviews , and discoveries (Lagena) , put focus on the complexity of different integrated inputs during birds' migration and related orientation (O'Neill *et al*, 2013) and it presents “*a formidable challenge for future research to overcome*”

We hope that our amateur's research and papers on PTO can stimulate curiosity and research applications by some young institutional researchers. Many fields (see Appendices) could be explored : anatomy-physiology, histology and electronic histology, electro-biochemical molecular fields, field and laboratory experiments over wild migratory birds and their anatomical structures and behaviours. Official institutional researchers could be at the forefront of important challenges for better knowledge of the migration ecology . They could be produce – better than me no-institutional amateur – correct studies and papers in official Journals .

6. REFERENCES

Birtsas P. *et al*. (2013) . “Abiotic factors and autumn migration phenology of Woodcock (*Scelopax rusticola*) in Mediterranean area”. *Italian J. Zoology*, **80**, 3, 392-401.

Breuner C.W., Spraguel R.S. and Patterson, S.H. (2013). “Environment, behaviour and physiology: do birds use barometric pressure to predict storms?” *J. Exp. Biol.* **216**, 1982-1990

Cavina, E. (2015). “Decision making of autumn migrations of woodpigeons (*Columba palumbus*) in Europe: analysis of the abiotic factors and atmospheric pressure changes”. *Science Heresy* <http://www.scienceheresy.com/ornithologyheresy/index.html>

[Giannessi F](#), [Ruffoli R](#), [von Bartheld CS](#). (2013). “Giovanni Vitali : Discoverer of the paratympic organ”. *Ann Anat.*; **195**, 1, 5-10 .

Metcalf J. *et al* (2013). “White-throated sparrows adjust behaviour in response to manipulations of barometric pressure and temperature” *Animal Behaviour* **86**, 1285-1290.

O'Neill P. (2013) “Magnetoreception and baroreception in birds” *Develop.Growth Differ.* **55**,185-197

[WEB-BIBLIOGRAPHY and various References](#)

here integrated / updated 2015 directly inside the Text , are available at <http://www.scienceheresy.com/ornithologyheresy/index.htm>

APPENDIX 1 – documented “evidence based” data concerning the Text are available at https://photos.google.com/share/AF1QipM79yvIsGsLOiiwU_wuU3evW2-Kpqr1jTfMZwQ6dw6zRUS44mmb0S2dA2uCXpN5Ag?key=QXFxeDMzVUV0WTcxbnNIRG43RIJhYjJOcXIRbnh3

APPENDIX 2 - Suggested applications' fields

An hypothetical experimental live-model to evaluate the effects of changes in Atmospheric Pressure over PTO in migratory birds (Common woodpigeons) during stop-over .

During first phase of Migration it's usual the falling of thousands birds in forests (stop-over areas as Mesola or S.Rossore forests in Italy or Central areas of France) The birds - fully biologically mature for migration- stop some days to refuel energies before to re-start : it is quite easy to capture by nets some tens of them for temporary experiments before release them to their migration .

Building two similar big net-boxes in the same wood of capture the researchers can study the monitored behaviours of birds by scientific parameters during the day and night (u.r. video camera) and also by bio-chemical parameters (metabolism) .

In a first box (local food available) the birds will be anatomically normal.

In a second box (same food) the birds will be with removed PTO (surgical technique as by past Bibliography , or by modulated cryosurgery or other methods allowed)) .

Monitoring behaviours' and biological parameters related to Atmospheric Pressure's changes , very probably will be possible to collect important analysis and statistical results ,comparing birds with / not PTO .

ANATOMY – HISTOLOGY – PHYSIOLOGY

Exploring anatomical structures in wild migratory birds .

Developing ultra-structural electronic investigations over neurological connections between middle-inner ear's structures (Lagena,PTO, spiracular organ) and Nervous Central System

Electro-physiologic investigations concerning barometric changes

Molecular studies over sensitive receptors of PTO .

OTHER related ELEMENTS

PTO of Woodpigeon – Anatomic pictures

https://photos.google.com/album/AF1QipOjBNVmwiWR7XIFoiBgSpZXSnQ3M-NU_wdmUB4f

PTO of Woodcock

https://photos.google.com/album/AF1QipN2c_oE9yKeKo4j7Q62oszo43Ul8oB_DAjupDxA

GRAPHICS of <http://www.scienceheresy.com/ornithologyheresy/index.htm>

<https://photos.google.com/album/AF1QipPBHSfuyIAPRP2pPfiOytZO5JaTTNKdabTUUqDj>