



Funded by
the European Union

NATURE **4** NATURE

Doctoral Candidate (DC4): Filter-feeding kinematics and hydrodynamics in ducks and paddlefish

Host Institution: University of Antwerp, Belgium
Secondments: Rijksuniversiteit Groningen, The Netherlands (RUG; 5 months)
Fraunhofer IWS, Germany (FHIWS; 5 months)

About Nature4Nature

Bioinspiration (including biomimetics and biomimicry) develops novel materials, devices, and applications inspired by biological structures and strategies. However, the main obstacle preventing this field from achieving its goals derives from differences in tools, practices and viewpoints of its practitioners. The EU-funded Nature4Nature project brings biologists, engineers, designers and manufacturers together to deliver early-stage researchers (ESRs) teaching in a learning environment that connects the inspiration, integration and implementation aspects of the bioinspiration process to undertake the conceptual, methodological and practical challenges. To do so, the project will collectively focus on biological filtration mechanisms to explore, test and design high-throughput, clog-resisting filtration systems, which could ultimately alleviate the current problems facing aquatic environments.

University of Antwerp

The University of Antwerp (UA) is the third highest ranked university in Belgium in terms of Excellence and has been awarded the HR Excellence in Research Award by the EU. UA has an excellent track record as to the participation in EU framework research and innovation programmes. Up until 25 October 2021, UA has signed 182 Horizon 2020 grants, incl. 47 MSCA Individual Fellowships, 27 MSCA Innovative Training Networks (of which 7 as coordinator) and 4 MSCA RISE projects. For the proposed Doctoral Network the efforts of two leading research groups are combined: the Laboratory of Functional Morphology (UA-FM) and Product Development Research Group (UA-PD). UA-FM (head: Prof. Peter Aerts), investigates how complex organismal systems function and evolve. The focus is on systems that are integrated and ecologically relevant, and both mechanistic and evolutionary approaches are used to questions in these fields.

DC4 will be hosted by the UA-FM group.

Project description

Biological filtration systems that can efficiently separate solid particles from liquids have evolved repeatedly as part of the feeding apparatuses of animals. As these are often high-throughput, clog-resisting filtration systems, they are valuable sources of inspiration for the design of novel artefact filters. This doctoral project will advance our knowledge on *in vivo* functioning of two promising model systems for bioinspired filtration: (1) cross-step filtration of paddlefish, and (2) tongue- and bill-powered filtration of dabbling ducks.

Paddlefish use a filtration method termed cross-step filtration, in which the vortical flow that is generated in the wake of the branchial arches causes cross-flow filtration. Although the system in paddlefish is highly clog-resistant, abstracted models based on the paddlefish filtration mechanism remain fouled by particles, indicating that the non-clogging properties are not yet understood. Data on the 3D *in vivo* geometry of the filtering apparatus during ram feeding, as well as detailed knowledge on the kinematics and intra-oral flows during the swallowing phase are required to explain how paddlefish remain clog free. During this swallowing phase, a backwash over the gill rakers is presumably created by a well-coordinated compression of the buccopharynx. Dabbling ducks are hypothesised to filter-feed using cyclical movements of the bill and tongue to create a flow of water that enters the bill through the gape and exits between the lamellae at the posterior of the bill. The filtration mechanism of dabbling ducks remains untested to date, partly because information on feeding kinematics and flow velocity patterns is lacking.

Intra-oral water flows and cranial kinematics of ducks and paddlefish during filter feeding will be analysed using multi-view videography and biplanar high-speed x-ray videography combined with x-ray particle tracking to visualise 3D water flows *in vivo*. The 3D posture of the branchial basket of paddlefish during filtration will be reconstructed. The kinematics and hydrodynamics of the swallowing motion in paddlefish as a potential filter backwash mechanisms will be described. Fundamental insight into the operation of the suction-pumping system of the beak and tongue in ducks will be obtained. During academic and non-academic secondments, the manufacturing options will be explored, for example to add bioinspired backwash in filter prototypes, and their effectiveness experimentally validated.

You will work (as main host institution) at the laboratory for Functional Morphology (www.uantwerpen.be/funmorph) where we investigate how organisms function and evolve. Many of our projects take a mechanistic approach: we try to understand how organismal systems work, i.e. how body parts (primarily of the movement and feeding apparatus) and processes interact. Secondments (5 months each) will be carried out at Rijksuniversiteit Groningen, The Netherlands and Fraunhofer IWS, Germany.

Profile & requirements

- Applicants must hold a master's degree or equivalent in the fields of Biology, Physics or Mechanical Engineering
- Applicants should have basic knowledge of programming (e.g. MATLAB, Visual Basic for Applications)
- Transcripts of the master's degree must be available by the date of the recruitment
- Applicants should have a strong affinity for research on animal morphology, biomechanics, and hydrodynamics
- Holding a certificate of laboratory animal scientist (FELASA category B or C equivalent) is a strong plus
- Applicants may be of any nationality but must comply with the Horizon Europe MSCA eligibility criteria*
- Applicants must be able to understand and express themselves in both written and spoken English to a level that is sufficient for the completion of a PhD
- All qualified applicants, including minorities and woman, are encouraged to apply

* **HORIZON MSCA Mobility Rule:** Applicants must not have resided or carried out their main activity (work, studies, etc.) in the country of the host organization (Belgium) for more than 12 months in the past 3 years immediately before the recruitment date. Compulsory national service, short stays such as holidays, and time spent as part of a procedure for obtaining refugee status are not taken into account.

* **HORIZON MSCA eligibility criteria:** Applicants may not hold a doctoral degree or equivalent at the start date of the recruitment. Researchers who have successfully defended their doctoral thesis but who have not yet formally been awarded the doctoral degree will not be considered eligible.

Benefits

- The selected candidate will be employed by the host organisation for **36 months**
- **The start date will be as of September 1st, 2023**
- The opportunity to be part of an MSCA Doctoral Network: the selected candidate will benefit from the designed training programme offered by the host organisation and the Nature4Nature consortium.
- The selected candidate will participate in international secondments to other organisations within the Nature4Nature network.
 - Doctoral candidates are offered a competitive remuneration based on the MSCA allowances in line with the [MSCA WP 2021-2022](#). The [gross monthly amount at UAntwerpen](#) corresponds to the amount for doctoral scholarship holders. Moreover, funding is available for technical and personal skills training and participation in international research events.

Application

- Interested candidates are invited to apply for this position: <https://www.uantwerpen.be/en/jobs/vacancies/academic-staff/?q=2526&descr=Doctoral-scholarship-holder-on-filter-feeding-kinematics-and-hydrodynamics-in-ducks-and-paddlefish>
- The closing date for applications is **January 31st, 2023**.
- The selection committee will review all the applications upon the application deadline.
- The recruitment process of Nature4Nature is in line with the principles set out in the [European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers](#).
- Ukrainian researchers are eligible to benefit from the Science4Refugees initiative without the need of holding the refugee status.

Additional information

- For more information on the Nature4Nature consortium, please visit our website at <https://www.nature4nature.net/>
- Any additional questions can be directed to the project manager, Genevieve Diedericks, at Genevieve.Diedericks@uantwerpen.be



Universiteit
Antwerpen



science4refugees