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Development of an application for the differentiation of the genus of Baird's sparrow (*Centronyx bairdii*) based on an artificial neural network

García-Fernández, Francisco[1]; Martínez-Guerrero, José H.[2]; Salazar-Borunda, Manuel A.[2]; Sierra-Franco, Daniel[2]; Pereda-Solís, Martín E.[2*]; Tarango-Arámbula, Luis A.[3]

[1] Escuela Técnica Superior de Ingeniería de Montes, Forestal y del Medio Natural, Universidad Politécnica de Madrid. Cd. Universitaria s/n. Madrid, España. C. P. 28040.
[2] Cuerpo Académico de Fauna Silvestre, Facultad de Medicina Veterinaria y Zootecnia, Universidad Juárez del Estado de Durango. Carretera Durango-Mezquital km 11.5, Durango, México, C. P. 34197.
[3] Colegio de Posgraduados, Campus San Luis Potosí. Posgrado en Innovación en Manejo de Recursos Naturales. Iturbide 73, Salinas de Hidalgo, San Luis Potosí, México. C. P. 78600.
* Correspondence: mepereda@ujed.mx

ABSTRACT

Objective: To develop a computer application with the possibility of being used in the field with high reliability to differentiate the sex of sparrows of the species *Centronyx bairdii*.

Design/Methodology/Approximation: A previously developed neural network was used to predict the sex of *C. bairdii* individuals. This algorithm was installed in an application developed using the MATLAB GUIDE environment for using graphic user interfaces.

Results: The computer application developed allows the introduction of morphometric data of individuals and predicts their sex with a confidence level of 92.3%.

Study Limitations/Implications: To install and run the application it is necessary to have a Windows version 7 operating system or later versions and the Matlab Ver. 7.5.0 software.

Findings/Conclusions: Through the computational application generated, it is possible to determine the genus of the species *Centronyx bairdii* with an accuracy of 92.3%. This is a useful tool for sexing birds of this species in the field.

Keywords: Baird sparrow, sexing, monomorphic birds.

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INTRODUCTION

Baird's sparrow (*Centronyx bairdii*) is a grassland bird native to the south of Canada and north of the United States, which during winter migrates towards various regions of the Chihuahuan Desert such as Arizona, New Mexico and Texas in the USA, and Chihuahua, Sonora, Durango and Coahuila in Mexico (AOS, 1998; CEC, 2013). Its populations have

shown a constant decrease during recent decades (Sauer *et al.*, 2017) and at the same time the need for its conservation requires greater research efforts (Berlanga *et al.*, 2010). An important physical characteristic of this species is that it has monomorphic plumage and its sex cannot be determined through its color or other observable characteristics (Figure 1). Determining the sex is a basic component to establish the proportion of males and females (PMF) in a population, as fundamental variable for demographic studies. The PMF represents an opportunity to understand the competence during mating, mating systems, and parental care of the chicks (Murray, 1984; McNamara *et al.*, 2000).

Sierra (2018) mentions that the most conventional techniques to determine the sex of monomorphic bird species are: a) exploratory dissection; b) use of bioacoustics; and the most recent, c) use of techniques based on DNA analysis. The latter implies elevated costs, in addition to being invasive for birds through the collection of blood or feathers.

In this regard, in the scope of classification, the use of artificial neural networks (ANN) constitutes a very powerful tool that has been used in other fields with satisfactory results. However, these networks have not been used very frequently in ornithology and they have been used primarily to distinguish the song between species (Lopes, 2011), and to a lesser extent to differentiate the genus of birds (Jennings *et al.*, 2008).

Recently, Pereda-Solís *et al.* (2020) developed an artificial neural network to determine the sex of *C. bairdii* with a confidence level of 92%. This ANN used as inputs the morphometric measurements of weight, wing chord, tail length, culmen, beak width, and beak depth. Because of this, the interest for translating this predictive capacity and for easing sexing of individuals of this species in the field emerges. Thus, the objective of this study was to develop a computer application with a high reliability to differentiate the sex of sparrows of the species *Centronyx bairdii*.

MATERIALS AND METHODS

Artificial Neural Network

Neural networks are defined as a computational system that imitates the computational capacities of biological systems (Hornik *et al.*, 1989). For this study the ANN developed by

Figure 1. Baird sparrow.

Pereda-Solís *et al.* (2020) was used, which generally consists of a multilayer perceptron type ANN with 4, 2 and 2 neurons in the hidden layers. It presents a confidence level of 92.3% which means that the model can distinguish between a male and a female sparrow with a level of accuracy higher than 92% (Figure 2).

Development of the application

To develop the application, a Dell Precision model T5500 computer was used, equipped with an Intel® Xeon E5603 processor at 1.60 GHz of 64 bits, Gallium 0.4 AMD CEDAR graphics card, with 3.8 GB of memory and a hard drive of 70.6 GB with operating system Windows 7. Programming was carried out through the GUIDE utility (Graphical User Interface Development Environment) which is available in the MATLAB version 7.5.0 software (MathWorks, 2017). This environment of visual programming allows designing graphic interfaces and executing software, as well as being a tool of great usefulness when a continuous data input or the active interaction with the user are required. In turn, GUIDE allows creating windows and dialogues in a simple way that contain basic components, such as labels, text fields, buttons and containers, among other elements.

RESULTS AND DISCUSSION

The interface was designed in MATLAB language and an auto-executable file (.EXE) was generated in a portable computer to favor its transport to the field. Through the introduction of the longitudinal data (mm) of wing, tail, culmen, beak depth and width, and weight of the individual (g), it is possible to obtain a high reliability in the sex of the bird as a result. This application, in addition to indicating on the screen the sex of the individual (Figure 3A), generates a file that can be edited in any spreadsheet (format .XLS) with all the morphometric data introduced by the user, as well as the solution generated (1=male, 0=female; Figure 3B).

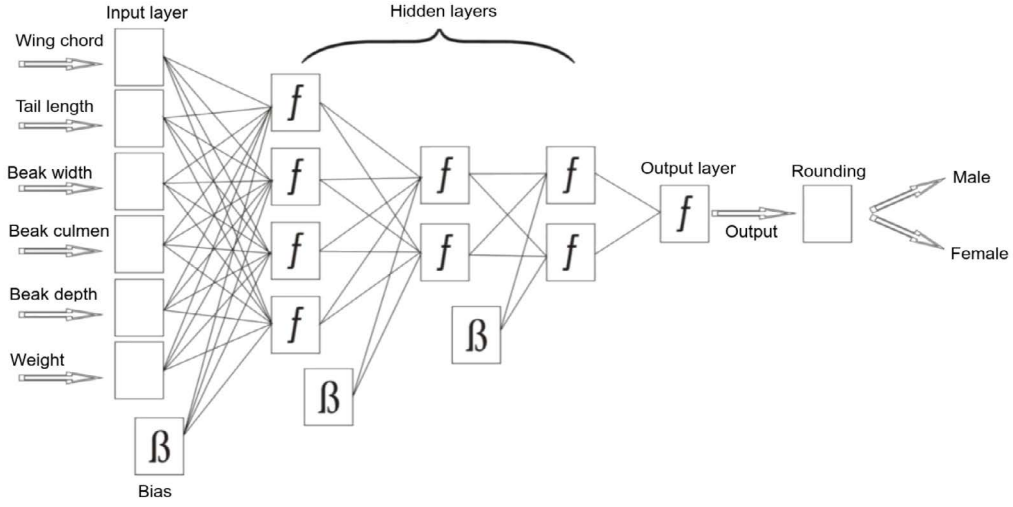
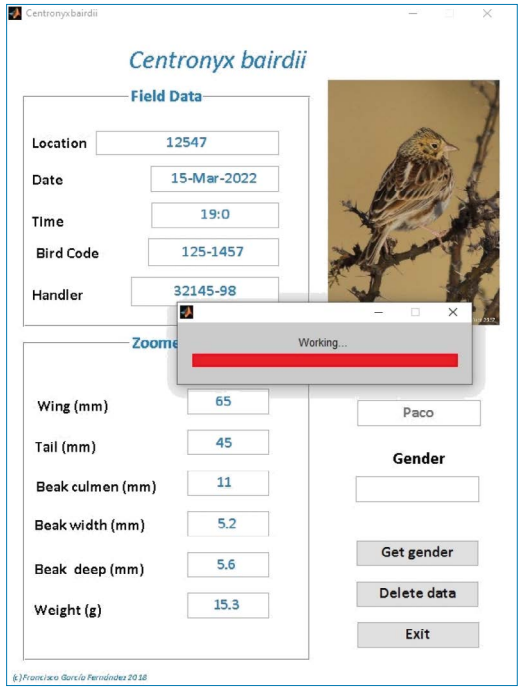


Figure 2. Scheme of neural network used to determine the sex of the Baird sparrow through morphometric data (Pereda-Solís *et al.*, 2020).

A



B

Bird code	Wing	Tail	Beak culmen	Beak width	Beak depep	Weight	Gender
262124874	68	48	11.1	5.6	5.8	18.3	1
262124875	66	45	10.8	5.2	5.8	17.4	0
262124876	69	47	11.8	5.6	5.6	18.2	1
262124877	67	45	11.4	6.1	5.6	15.9	0
262124878	70	50	11	5.7	5.9	17	0
262124880	67	49	11.2	8.8	5.5	16.8	1
262124881	67	48	10.9	5.7	6.3	16.3	0
262124881	67	48	10.9	5.7	6.3	16.3	0
262124882	69	48	11.6	6.2	5.1	17.1	0
262124883	67	50	11.5	5.5	5.9	16.4	0
262124852	67	49	12	5.6	5.5	16.8	0
262124853	69	45	11.7	5.4	5.6	16	0
262124857	68	46	11.8	5.9	6.5	18.8	1
262124858	66	47	11.4	5.4	5.7	17	0
262124859	67	46	11.2	5.4	6.2	17.1	0
262124860	69	48	11.6	5.5	6	18.3	1
262124861	67	44	12	6.5	6	17.1	1
262124862	66	44	11.4	6	5.7	15.9	0

Figure 3. Application screen (A) and results file (B).

CONCLUSIONS

A computer application was developed from an ANN, which through capturing morphometric data of sparrows of the species *Centronyx bairdii* can determine the genus with an accuracy of 92.3%. This application is a non-invasive, useful, fast and economic method for sexing birds of this species in the field.

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